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THE BENEFICENT MAN

By RUFUS T. STROHM

I THINK I've found the kindest man that's trod this earth since time began. Compared with his humane repute, the good Samaritan's a brute. And Androcles —so richly thanked because he kept his nerve and yanked the long and painful thorn he saw embedded in the lion's paw —why, Andy is a Frankenstein beside this noble man of mine.

He's not a judge, a plutocrat, a duke, or anything like that, but just an humble engineer who earns his bread and nearly-beer by tending boilers at the mill of Pettibone and Underhill. And yet, as through his work he goes, it's very doubtful if he knows that he is sowing mercy's seeds and executing kindly deeds.

His steam pipes all are black and bare, emitting heat waves everywhere, that roll in surges far and wide and strike the rafters in a tide; they warm the spider as he crawls along the dusty, webby walls, and keep each pert, inquiring fly in cosy comfort, brisk and spry, while rats and mice, on forage bent, abide in peace and sweet content.

His chimney gases—roaring hot as that unmentionable spot to which the minister alludes as peopled by unrighteous broods—give to the near-by atmosphere a gentle warmth and kindly cheer, so that the microbe and the gnat that make the air their habitat, are spared the pain of frozen toes, bronchitis, grippe and other woes.

In fact, our gentle hero feels compassion for the bass and eels that in the cold and limpid brook play fast and loose with fly and hook; because the water that he taps from heaters, cylinders and traps, goes promptly to the babbling rill to moderate its numbing chill; and so the fishes do not freeze, but live as though in tropic seas.

You think his heart is soft? Instead, the softness all is in his head!

Burning Powdered Coal and Blast-Furnace Gas at River Rouge

By THOMAS WILSON

Details of the arrangement and construction of the big boilers and their control. The pulverized-coal equipment and the layout of the gas piping and burners. Performance guarantees and the operating force required.

IN THE introductory article on this plant reference was made to the large boilers, but space was not available to give more than passing notice. At this writing they are the largest single units in operation, each containing 26,470 sq.ft. of steam-making surface. The final plant is to contain eight of these boilers, four on either side of the boiler room. Four boilers are now installed to serve two generating units, three turbo-blowers, two air compressors and to meet the other demands for steam mentioned in the preceding article.[1] The other four will go in when the balance of the equipment to be served is installed.

They rise to a height of 83 ft. above the ash floor, and still higher up space has been provided for economizers. The vertical arrangement of the heating surface and an immense furnace giving sufficient volume for the simultaneous burning of blast-furnace gas and pulverized coal, have contributed to the height. Between column centers each boiler measures in plan 29 x 31 ft., covering a floor space which reduces to 0.034 sq.ft. per square foot of steam-making surface.

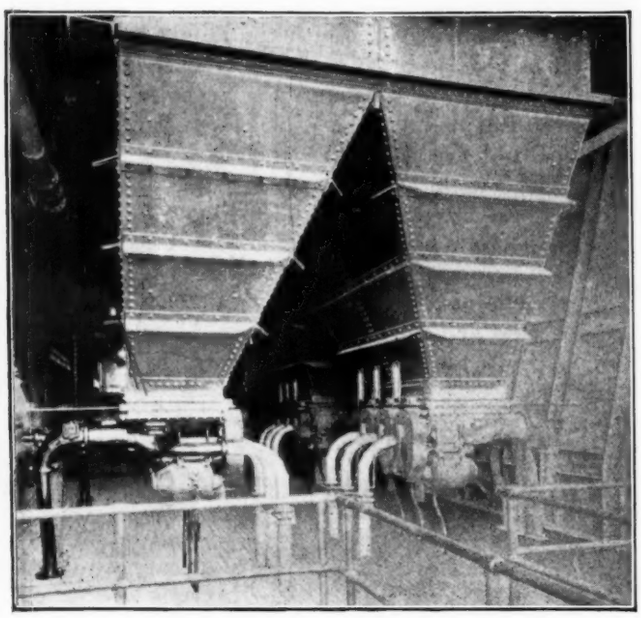

FIG. 1. PULVERIZED-COAL FEEDERS OVER CENTRAL AISLE BETWEEN BOILERS

Reference to Fig. 5 will show that the boilers are of the double-ended type with an element on either side consisting of an upper and lower drum connected by three banks of tubes 3¼ in. in diameter and an average length of 20 ft. 6 in. Placed end to end, the 1,467 tubes between drums in one boiler would extend a distance of nearly six miles. Each of the four drums is 60 in. diameter and nearly 26 ft. long. From these two elements steam is fed to a 36-in. drum placed above and at the center line of the boiler, and is discharged through two 10-in. nozzles to the two saturated-steam headers of the superheater.

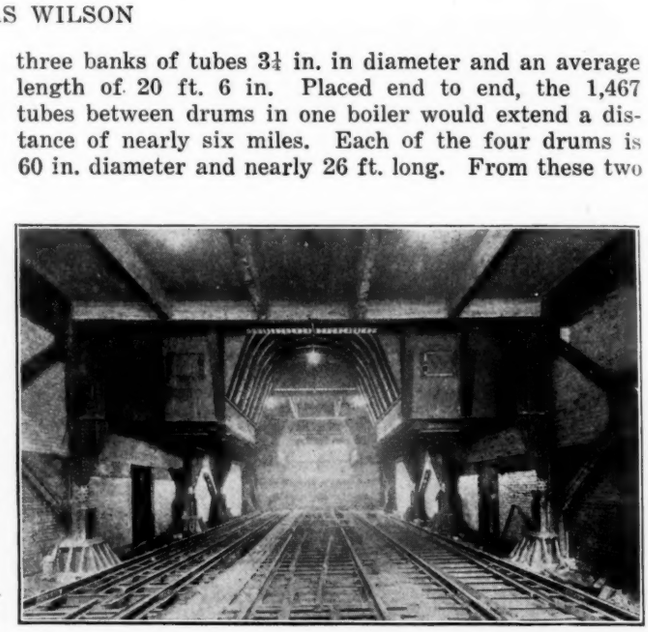

FIG. 2. ASH HOPPERS AT GRADE TO DISCHARGE TO RAILWAY CARS

A superheater is located in each half of the boiler, receiving steam from its respective saturated-steam header and delivering to the common superheated-steam header located between them, the three headers being shown in Fig. 5 between and at a level just above the top drums of the two boiler elements. The superheater discharge header is 12 in. diameter and delivers through two 10-in. outlets to the piping system.

Each of the superheating elements is composed of 60 units of 1½-in. outside-diameter seamless, drawn-steel tubing and both elements contain about 3,000 sq.ft. of surface. The location between the tubes in the first pass is unusual. Spacers hold the superheater units in place. They are protected by several rows of boiler tubes, and the units nearest the furnace are shorter than those farther back, as the gases here are hotter and less obstruction is offered to the gas flow between the tubes. This arrangement is favorable to securing the degree of superheat desired. The elements are in the path of the hottest gases and yet some protection is afforded. They hang almost vertically, so that they may be kept clean easily and are free to expand or contract.

A feature is the use of forged return bends. By means of a special forging process the metal is distributed so as to give an increased thickness at the bend, making it stronger than the pipe itself. This construction results in a continuous pipe for each unit, reducing the friction at the turns and affording the greatest protection where the hottest gases impinge. Connections of the superheater units to the headers are made outside the setting, away from the hot gases. A special metal-to-metal ball joint is used, the ball portion

[1] See *Power*, March 1 1921, and Sept. 6, 1921.

being forged to the end of the superheater pipe and ground to a true sphere. In the header the seat for this ball also is ground and the joint is kept tight by a clamp and alloy-steel bolt of high tensile strength. For inspection or repair of the superheater, it is not necessary to go within the setting, and another advantage is the provision for disconnecting and removing any one of the units without disturbing the others. The superheat is to be 200 deg. and the operating pressure 225 lb. gage, giving a final steam temperature of nearly 600 deg. F.

From each superheater the steam passes through two 10-in. stop and check valves, and the two 10-in. lines unite into a 12-in. main which drops 60 ft. to a loop header on the pipe-gallery floor. In this header single offset and double U-bends take care of the expansion. At intervals the header is anchored by means of special fittings provided with feet that are bolted directly to the building steelwork. The piping between anchors rests on sliding or spring supports. The piping was sprung when erected, so that the strain due to expansion when the header is filled with steam will be offset. At all points of entrance or take-off special enlarged fittings are employed so that the steam velocity will be reduced to lessen the resistance at these points. From enlarged tees the turbines supply lines lead out horizontally and pass up through the turbine-room floor to the respective units. Motor-operated sectionalizing valves are used generally, and other valves requiring frequent manipulation are operated from floor stands. The high-pressure piping generally is of steel; the fittings and valves are cast steel, the latter having monel trim; the flanges are forged steel with Van Stone joints.

The products of combustion divide, half making three passes through each element and passing vertically through an uptake on either side of the boiler. These uptakes discharge into a breaching which unites into a common smoke flue leading to the stack above, each boiler having an independent steel stack, 11 ft. in diameter, rising 200 ft. above the roof and 327 ft. above the ash-floor level. The stacks are supported on the upper steel structure of the boiler house with special vertical steel columns to take the weight.

The sectional view of the boiler gives some indication of the furnace design and its great volume. Inside plan measurements are 23 x 24 ft. and the height above the ashpits, 55 ft. Taking into account the irregular shape, the volume approximates about ½ cu.ft. per square foot of steam-making surface. On the assumption that powdered coal was to be burned exclusively, this would give about 1¼ cu.ft. of furnace volume per pound of coal burned, and with the normal operation at 250 per cent of rating anticipated, the volume per pound of coal consumed would reduce to 0.5 cu.ft. The preceding figures were estimated on the basis of 4 lb. of coal per 10 sq.ft. of boiler-heating surface, and as this allowance is ample, the furnace volume falls within the range found elsewhere in practice to give the best results.

By means of four burners on either side, blast-furnace gas is fed horizontally into the furnace near the bottom. For powdered coal there are twelve feeders and four triplex burners, two on either side of the

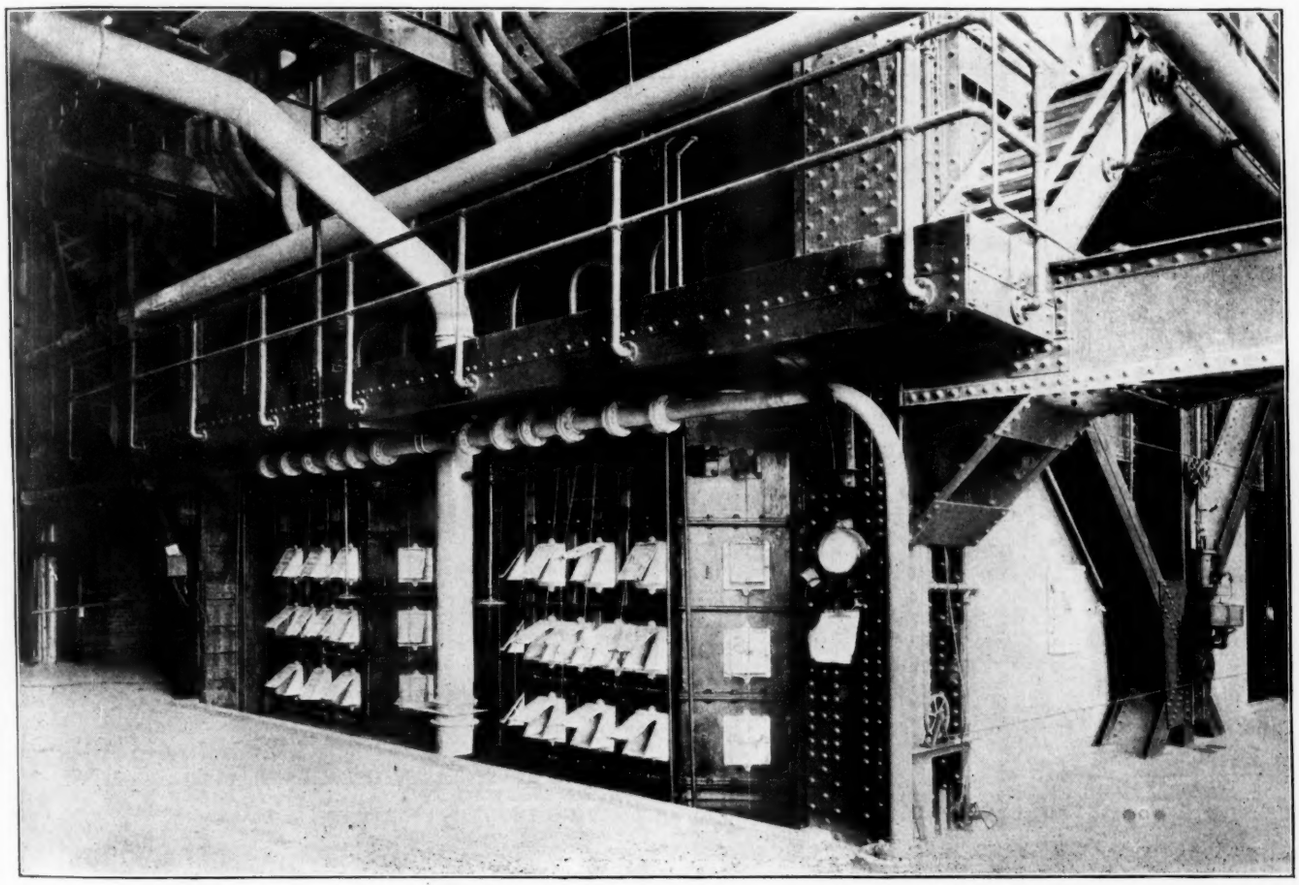

FIG. 3. AIR DOORS IN FURNACE FRONT

boiler, the latter being located in a recess under the lower boiler drum and feeding down into the furnace close to the front wall.

To prevent overheating of the front walls and to provide a flexible arrangement for providing air in sufficient quantities and at the location desired, numerous small doors or dampers have been provided in the furnace fronts, their location and number being indicated in Fig. 3. The entire set on each half of each furnace front are chain-connected to a horizontal roller, so that they may be opened or closed in unison. The entire structure of the boiler, superheater and setting is supported on the building steel, the total weight, exclusive of the stack, approximating 2,250,000 pounds.

Owing to the proposed operation at high ratings and the resulting high furnace temperatures, unusual precautions were taken to guard against expansion strains and to insulate the walls, the necessity for these precautions being increased by the fact that the side walls are 50 ft. high and the front walls to the bottom of the lower drum about 25 ft. To provide for expansion in the main boiler drums, which are nearly 26 ft. long, toggle hangers from the main suspensions support one end while the other end of the drum is fixed, so that expansion is all one way. The superheater headers are fixed at one end and slide at the other. Horizontal expansion in the side walls is taken care of by expansion joints of asbestos and mineral wool at the corners of the setting. The lower drums have shoes at either end which rest on brackets secured to a plate girder extending across the boiler end. This allows the drum to expand endwise while still keeping it in line with the upper drum. The side walls are provided with three relieving arches so that any particular section of the wall may be removed without taking down the entire structure. In the heating surface the baffles are made up of special tile which lock between the tubes, the outer ends being curved to the shape of the tubes. They consist of small light blocks easy to replace, and at the point where these baffles extend into the side walls they are backed up by mineral wool, which may be compressed to allow for expansion in the refractory.

Fig. 5 gives some idea of the construction of the furnace walls. The lower main side walls are 33¾ in. thick at the bottom and decrease in thickness as they go up to 22½ in. at the top. At the center a 9-in. invert enters into the construction at the bottom of the wall and a 4½-in. invert at the top. In the furnace all high-temperature zones are lined with 13½ in. of firebrick. The boiler fronts inclosing the third pass of the heating surface on either side have steel casings protected by 5 in. of refractory brick and insulated with 2½ in. of insulating material. The dampers are made in three

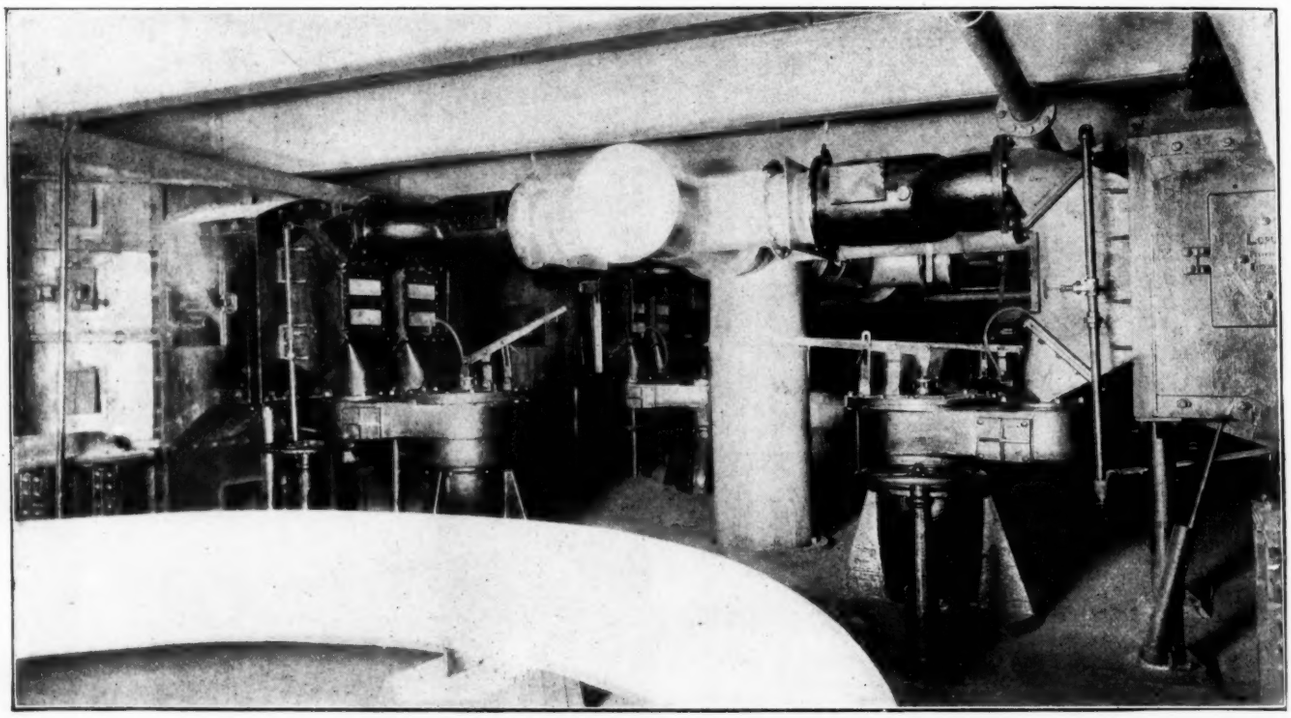

FIG. 4. GAS BURNERS IN CENTRAL AISLE SERVING BOILERS ON EITHER SIDE

sections with joints between to allow for expansion. They rest on cast-iron rollers.

On either side the furnace has cast-iron front walls lined with 13½ in. of firebrick. They are supported by three buckstays bolted to the casting. The sway bracing between columns together with the horizontal supporting girders act as buckstays to the side walls.

For protection of the lower drum and to give access to it for feed-water and blowoff piping, as well as to provide space for the powdered coal burners, the front walls terminate at some distance below the lower drum and the offset is effected by a short horizontal arch and a vertical flat arch extending up to the horizontal center of the drum. These arches are supported by cast-steel hangers from the structural steelwork.

At the bottom of the furnace is a large ashpit divided into four hoppers, each of which is fitted with a 3 x 4-ft. ash gate operated by an air piston. In the arched bottom of the ashpit inspection doors are provided and also end doors in the side walls. Besides permitting

inspection, these doors provide openings through which the slag may be loosened in case of necessity.

As previously stated, the fuel for these boilers is to be blast-furnace gas and pulverized coal, the latter to be used to meet steam requirements above that supplied by the gas. Normal operation at 250 to 300 per cent of

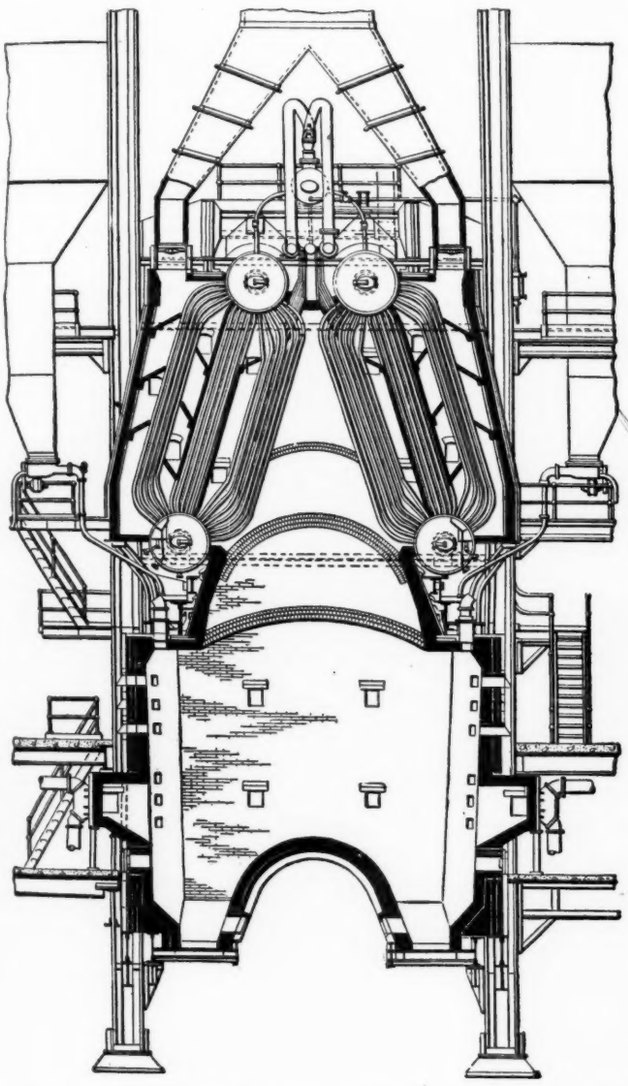

FIG. 5. VERTICAL SECTION THROUGH DOUBLE-ENDED BOILER

boiler rating and peak loads exceeding 400 per cent of rating are anticipated. The gas available ranges from 90 to 100 B.t.u. per cu.ft. and per day of 24 hours about 50,000,000 cu.ft. will be available from one blast furnace. With four boilers and two furnaces ready for operation the quantity of gas given previously will be supplied to two boilers. On a basis of 70 per cent efficiency this amount of gas is only sufficient to develop continuously about 80 per cent of nominal rating on each boiler, so that if the boilers are operated according to expectations, the greater part of the load will be carried by powdered coal.

From the blast furnaces the gas comes to the power plant through an 8-ft. main which is brick-lined to protect the steelwork and to help maintain the temperature of the gas. This 8-ft. line will take the gas from two blast furnaces, and when the other two furnaces are installed, there will be need for another main of the same size. At the power plant these two 8-ft. mains will combine into a 10-ft. header which is already in place. From this header four 5-ft. branches lead off to supply the burners on either side of each row of boilers, the header and likewise the branches reducing in diameter as they proceed. The 5-ft. branches are taken off from drop legs under the main header, which serve not only as supports for the header, but also as dust pockets, a clean-out door being provided near the bottom. The pressure on this gas, after it is forced over from the furnaces through cleaners to the power plant, ranges from 6 to 10 in. of water. This pressure forces the gas through shutoff valves in the 5-ft. branches into 20-in. risers leading up to the firing floor and supplying gas to one side of the boiler.

On this riser is a globe-type valve with a Y-outlet leading to two blast-furnace gas burners placed side by side and projecting into a small dutch oven carried out about 3 ft. in front of the setting. The burners are of the gridiron type in which air and gas pass through alternate slots approximately $\frac{3}{4}$ in. wide. By splitting the air and gas up into fine streams, more thorough mixing is obtained. To control the supply of air, the shutoff in the gas riser is used as an orifice, the drop in pressure through this valve in conjunction with the

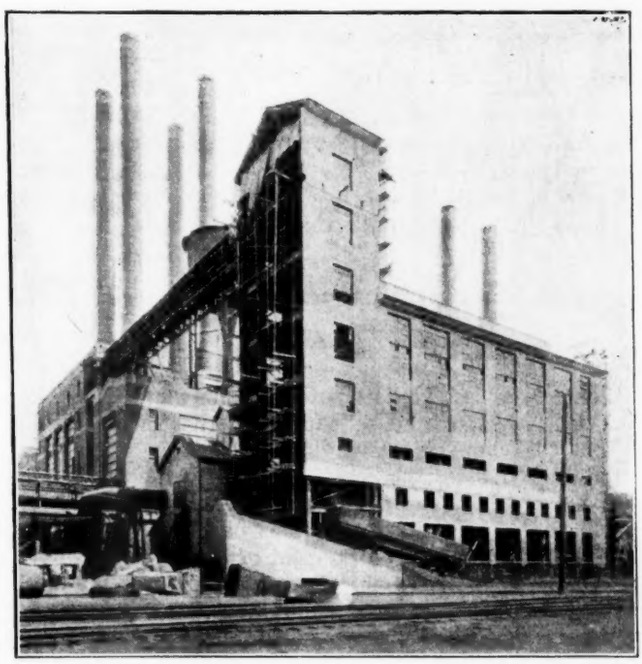

FIG. 6. COAL-PULVERIZER HOUSE AND COAL TOWER WITH BRIDGE ACROSS TO BOILER HOUSE

drop in pressure through the shutoff valve in the air line acting upon a regulator of the diaphragm type which controls the position of a butterfly valve in the air line. By setting the shutoff valves in both gas and air lines to give the proper combustion ratio at any one pressure, the regulator will then vary the amount of air supplied as the gas pressure changes and maintain a mixture of constant ratio.

Three large turbo-vane fans are provided to supply the air. Each has a maximum capacity of 45,000 cu.ft. per min. at 8 in. static pressure, and is driven by a

special slow-speed motor with a wide speed range. Three fans have been installed for the two blast furnaces, thus giving a reserve, as one fan will supply sufficient air for the gas coming from one blast furnace.

For the solid fuel the usual coal from the Ford mines in West Virginia and Kentucky or coke braize from the coke ovens will be used. For full operation it has been estimated that a thousand tons of this coal will be consumed per day. From the mines to the ashpit none of it will be handled manually. A full complement of conveyors in the pulverizing house and the boiler room, and the final removal of the ashes in railway cars under the ash hoppers, make all operations mechanical.

The coal is taken from storage or is unloaded directly from cars by a car dumper which tilts the car and empties its contents into a hopper delivering onto a belt conveyor which carries the coal to the breaker building of the coke plant. The coal is crushed into 1½-in. cubes and is carried by another belt conveyor to a 90-ton hopper in the pulverizer house. From this hopper it is taken by an inclosed apron conveyor measuring 103 ft. on centers and is distributed into an overhead bunker in the pulverizer house supplying the various mills. From this bunker, which has a capacity of approximately 700 tons, the coal is chuted to the feeders of the pulverizers, the latter being six-roll low-side mills, each having a capacity of 6 tons per hour. The mills crush the coal so that 85 per cent of it will pass through a 200-mesh screen and 95 per cent through a 100-mesh screen, but later coarser grinding may be adopted. At present four units are installed although the entire building is up and the final layout calls for twelve mills, arranged six on either side of the pulverizer building.

All the mills are belt-driven by induction motors. They operate on the air-separation principle. This air is supplied by an exhauster pulling from the mill and discharging through a cyclone collector on the third floor of the pulverizer building. The coal separates from the air in the cyclone and discharges to either one of two 14-in. screw conveyors, the air passing back to the mill. Between the cyclone and the conveyors excess air is separated from the coal in tubular separators placed in individual rooms, the air escaping through a monitor in the roof fitted with louvers.

As the screw conveyors are installed in duplicate and there are two rows of mills, four 14-in. screw conveyors lead to the coal tower at the end of the pulverizing house. Here the four screw conveyors discharge to four bucket elevators which raise the coal to the top of the tower and deliver it to either one of two 16-in. screw conveyors leading across a bridge to the boiler house. Arrangements have been made so that either screw conveyor of a pair can discharge to either bucket elevator of the same set. All the screw conveyors are driven by induction motors through inclosed silent-chain drive, while the elevators are belt-driven by induction motors, as in either case there is no occasion for any variation in speed.

Upon entering the boiler house the 16-in. screw conveyors, which have passed over the bridge, discharge into either one of two 16-in. screw conveyors running transversely across the end of the boiler house. These conveyors in turn deliver into any one of four 16-in. screw conveyors running lengthwise of the boiler house, one on each side of each row of boilers and distributing the coal to individual bunkers serving each boiler. The bunkers are made of steel plate lined with concrete. Those at either side have a capacity of 200 tons each and those over the central aisle will hold 350 tons. It will be seen that all conveyors except those over the boiler-house bunkers are in duplicate, each being capable of handling the entire power-house load.

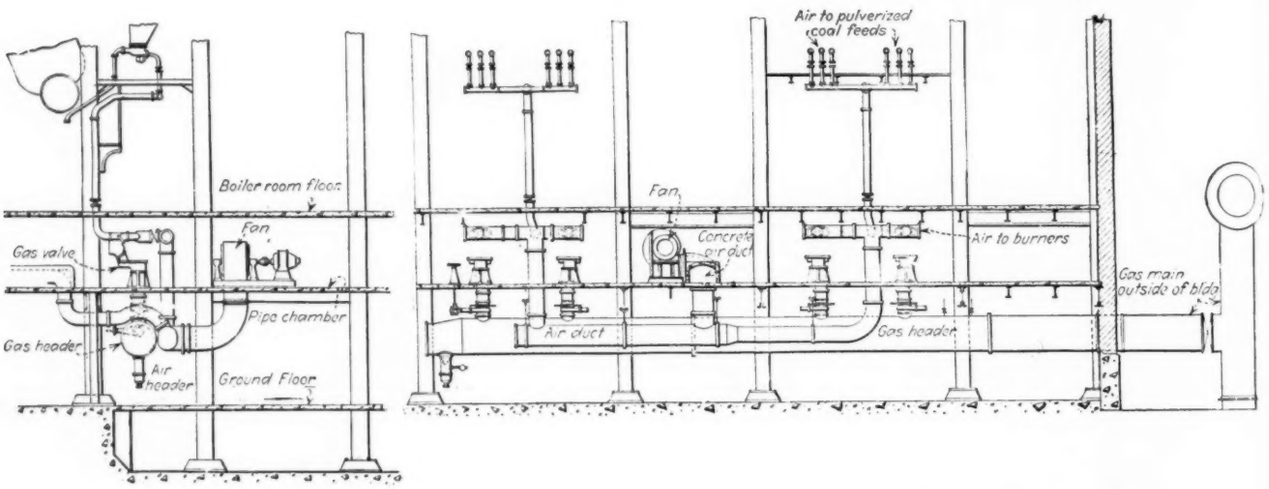

FIG. 7. TYPICAL GAS AND AIR LINES SERVING ONE SIDE OF A BOILER

Following through in order, the prepared coal now passes down to standard feeders, of which there are two sets of three each for each side of the boiler, or twelve in all. A sliding gate controls the flow of coal to each feeder so that any particular unit or set may be shut off as desired. From the feeders the coal passes to pipe lines leading to the burners, which discharge vertically downward into the furnace. A small quantity of air is admitted to the feed pipes to pass along with the coal to prevent clogging, and in order that the length of the flame or the combustion may be varied by variation of the air pressure. Depending upon the load carried, the pressure ranges from 5 to 10 in. of water. Air for this purpose is supplied from the gas-burner air line, with a valve near the coal feeder for varying the supply of air as required to give the desired pressure. Due to this arrangement, some air is admitted at the burners, but the greater portion of the air to support combustion and keep furnace temperatures within safe limits passes through auxiliary doors or dampers placed

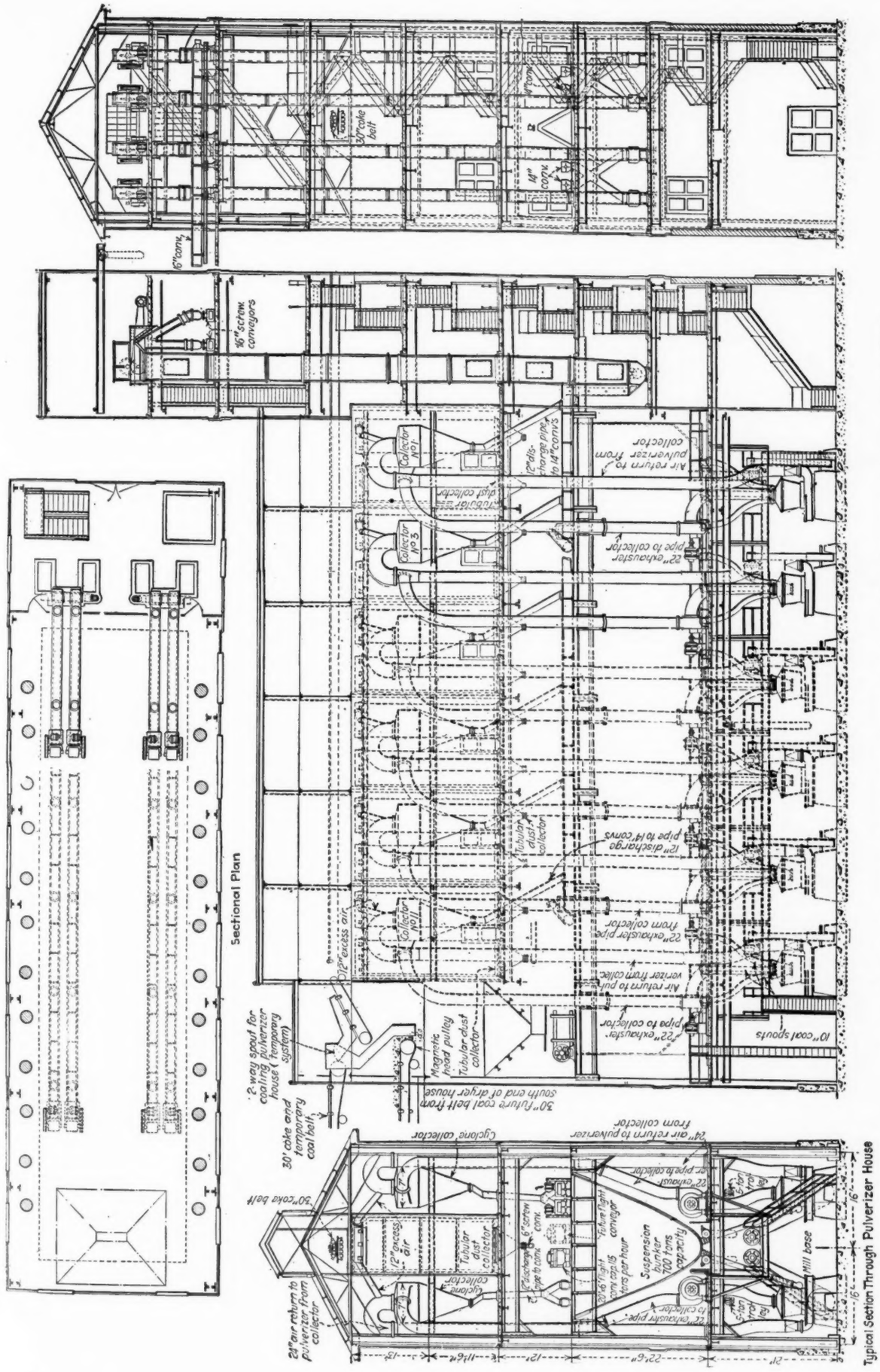
Sectional Plan
Typical Section Through Pulverizer House
16" screw conveyors
Collector No1
Collector No2
Collector No3
Tubular dust collector
Cyclone collector
Tubular dust collector
Magnetic head pulley
Suspension bunker 700 tons capacity
Mill base
10" coal spouts
30" coke belt
30" fluxing coal belt from south end of dryer house
2 way spout for coaling pulverizer house (temporary system)
30' coke and temporary coal belt
24" air return to pulverizer from collector
Air return to pulverizer from collector
12" discharge pipe to 14" conv's
22" exhauster pipe to collector
12" excess air
23" air return to pulverizer from collector
16" conv.
14" conv.

FIG. 8. SECTIONAL PLAN AND ELEVATIONS OF COAL-PULVERIZER HOUSE AND TOWER

at various heights in the furnace fronts. There are a number of these doors for each set of three burners, and they are all controlled simultaneously by means of chain connections to a roller which is turned by means of a handwheel.

The feeders are motor-operated and are controlled by means of rheostats on a special control board provided for each boiler. With both field and armature control these motors have a speed variation of three to one. The controlling mechanism is so arranged that the speed of each feeder may be varied at will or all feeders in use on one boiler may be varied in unison by a master controller. The revolutions of the feeders are recorded by solenoid-operated counters on the control board, and as the screw feeders are calibrated for the particular coal used, the weight of the coal fed to each boiler is obtained.

It is interesting to know that the control for all conveyors, elevators, exhausters and mills, is centered at one point, and that connections have been so made that it is impossible to start the machinery in reverse order. Beginning with the conveyors over the bunkers in the boiler house, the machinery must be started in sequence back to the mills in the pulverizer house. At various points emergency stops are placed so that the equipment may be shut down in case trouble develops without going back to the central control board. These stops automatically shut down all of the equipment back of the apparatus on which the trouble develops.

Individual and group controls are located on the side panels of the control board and the meters and draft gages on the center panel. On this central panel is a steam-flow meter with two differential air-flow pens and another meter to record stack and steam temperatures, thus giving the essential data necessary for boiler operation. Summarizing, the steam flow, gas flow through the setting, stack temperature and steam temperature are recorded and drafts are indicated by differential draft gages. No CO_2 recorders are used, owing to the varying proportions of the blast-furnace gas and pulverized coal. The settings of the differential air-flow pens on the flow meter are checked daily by analyzing with an Orsat the escaping gas for CO_2, CO and O_2. A master controller operated from the flow and pressure of the steam from the boilers to the turbo-generators has been provided and can be set to control all four of the boilers or any one boiler. It will respond to variations of pressure of ¼ lb. per sq.in.

In reviewing the operating force in the boiler room, one operator is required for the four boilers on the pipe-gallery floor looking after gas and air valves, another on the boiler-room floor to take care of the pulverized fuel equipment, a third on the water tender's gallery, another operator to look after the soot blowers and a chief operator, making a total of five men per shift. Taking into consideration that the various operations mentioned are at different levels, the force employed is unusually small.

Two of the boilers have been in operation for several months on powdered coal and no particular trouble has developed. The pulverized coal has been burned without drying and ratings up to 250 per cent of nominal have been attained. Plans are being made to utilize the large quantities of coke braize available, but as this contains 15 per cent moisture, some drying will be necessary.

No official tests have been made on the big boilers, but it may be of interest to summarize briefly the guarantees. The furnace efficiency, when operating on pulverized fuel alone, was not to decrease more than 1 per cent up to a fuel consumption equivalent to a boiler rating of 250 per cent of the nominal. The losses through unconsumed combustible, when operating at a combustion rate equivalent to 450 per cent of boiler rating on pulverized fuel alone, in the form of CO in the stack gases, together with the unconsumed carbon in the ash, was not to exceed 2 per cent of the coal as fired. An average combined furnace and boiler efficiency, when operating on pulverized fuel containing less than 3 per cent of moisture, of not less than 82.5 per cent was to be attained, with the boilers operating at 275 per cent of their nominal rating over a period of 24 hours. On blast-furnace gas having not less than 90 B.t.u. per cu.ft., the boilers were to be operated up to 150 per cent of their nominal rating. The furnaces were designed to be operated continuously under any desired combination of blast-furnace gas and pulverized coal up to a furnace capacity equivalent to 400 per cent of the boiler rating. Power required to convey, pulverize, feed and burn the coal was not to exceed 15.5 kw.-hr. per ton of coal burned, when operating on bituminous coal containing not more than 10 per cent ash and 3 per cent moisture and when operating to capacity.

These are the conditions that the boilers were designed to meet, and as soon as the data are available, it will be of great interest to see how closely the requirements have been met.

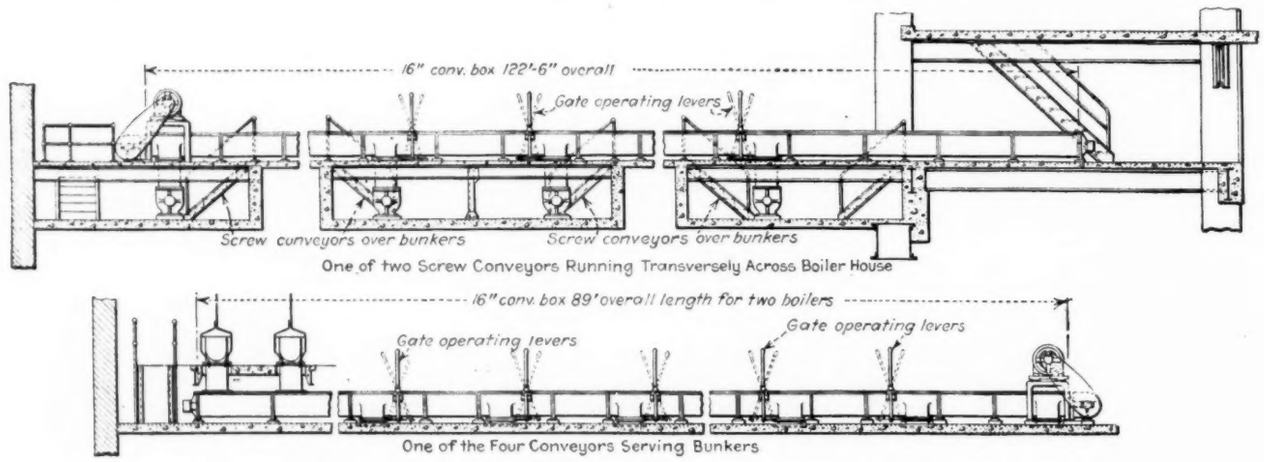
16" conv. box 122'-6" overall
Gate operating levers
Screw conveyors over bunkers
Screw conveyors over bunkers
One of two Screw Conveyors Running Transversely Across Boiler House
16" conv. box 89' overall length for two boilers
Gate operating levers
Gate operating levers
One of the Four Conveyors Serving Bunkers

FIG. 9. TRANSVERSE AND LONGITUDINAL COAL CONVEYORS IN BOILER HOUSE

Locating Faults in Direct-Current Armatures—Single-Series Windings*

Requirements for Single-Series Armature Winding Explained—Effects of Open Circuits—How To Test and Locate These Defects—Methods of Repairing Open Circuits

BY B. A. BRIGGS

ANY number of coils can be grouped into a single-parallel winding and have the winding symmetrical, but with a single-series winding certain conditions must be satisfied, and only specific numbers of coils that will meet these conditions can be grouped into a symmetrical winding. The conditions are that the number of coils $N = \left(\frac{P}{2} \times Y\right) \pm 1$, where P is the number of poles and Y equals the nearest whole number to the number of commutator bars divided by the pairs of poles. In the last article (Oct. 4 issue) 24 coils were connected into a single-parallel 4-pole winding. There were 24 segments in the commutator and two pairs of poles. Then $Y = 24 \div 2 = 12$, and if this number of coils (24) will connect into a single-series 4-pole winding, the number of coils N must equal $\left(\frac{4}{2} \times 12\right) \pm 1$. Now $\frac{4}{2} \times 12 = 24$, and if 1 be added to or taken away, the result is 25 or 23 respectively; therefore we know that 24 coils cannot be connected into a single-series winding, but 25 can. For this reason, when the diagram Fig. 1 was made, 25 coils and not 24 were used, and the spread of the leads on the commutator has been taken at *1* and *13* or *12* segment between leads.

The polepieces are shown in dotted lines and are supposed to be above the surface of the paper, consequently the N pole flux will be down through the paper where the S pole flux will be up. If the armature moves in the direction of arrow K the arrows on the coils show the direction of the voltage. The winding is the same as if it were on an actual armature, and if the two ends are brought together coil sides A, B, C, D, E, F would fall into slots A', B', C', D', E', F' and leads a, b, c, d, e, f on the left will connect to leads a', b', c', d', e', f' on the right, likewise leads g, h, i, j, k, l on the left connect to g', h', i', j', k', l' on the right.

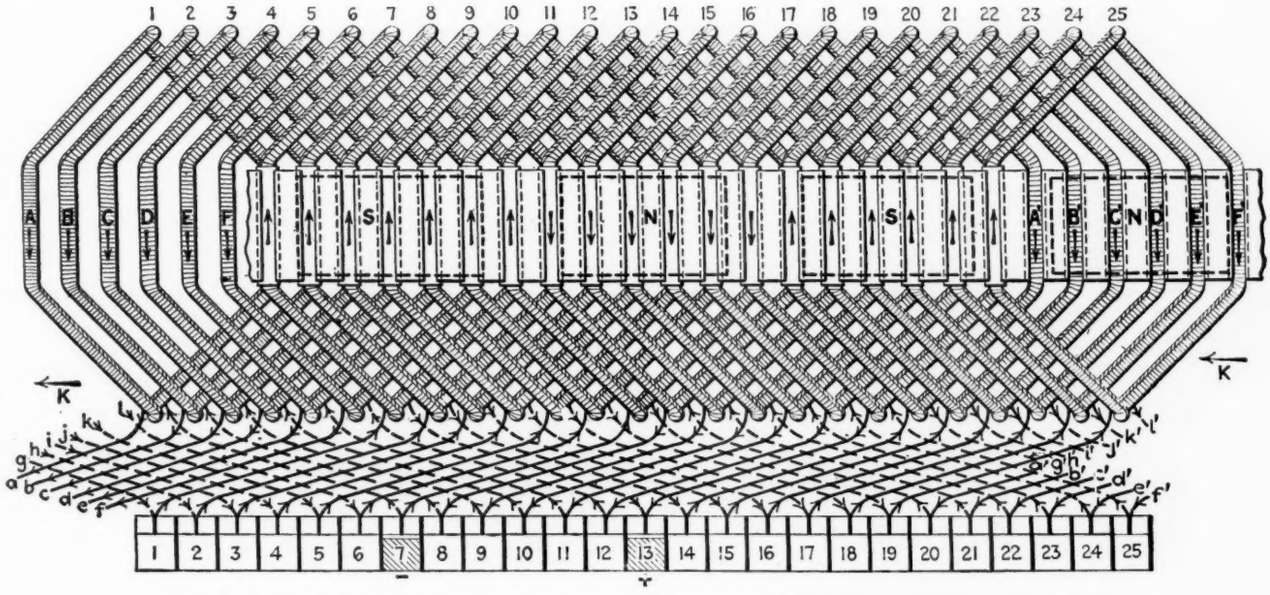

FIG. 1. SINGLE-SERIES FOUR-POLE ARMATURE WINDING, HAVING TWENTY-FIVE COILS

In tracing out the circuits through this winding, there are two. One of these circuits is from the negative brush or segment *7* though coil *1*, to *a* and to segment *20*, from segment *20* through coil *14* to segment *8*, then through coil *2* to *b* and to segment *21*, the circuit continues through coils *15*, *3*, *16*, *4*, *17*, *5*, *18*, *6* and *19* to segment *13*, on which the positive brush rests, as indicated by the arrows and arrowheads. The other circuit through the winding is from the negative brush on segment *7* through coil *13* to segment *19* and through coil *25* to *l* and segment *6*, then through coils *12*, *24*, *11*, *23*, *10*, *22*, *9*, *21*, *8*, *20*, *7* and to segment *13* to the positive brush. In these two circuits are included all the coils in the winding. It will be noted that twice the number of coils are in series between brushes as with the parallel winding discussed in the Oct. 4 issue. If the machines are otherwise identical, the single-series winding will generate twice the voltage of the single-parallel winding.

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In the single-series winding only two sets of brushes are required on the commutator, irrespective of the number of poles. These brushes are set one pole space apart and, as shown in Fig. 1, will include all the coils in the two circuits in the winding. It is general practice in machines above 3½-hp. capacity to use a set of brushes for each polepiece as with a parallel winding. Note that the brushes in the figure are not spaced exactly one pole space apart, as they should be in practice. However, the arrangement in the figure simplifies the circuits in the windings and is therefore adopted.

If an open circuit occurred in the winding, Fig. 1, as at *X* Fig. 2, then one-half of the coils would be dead. In Fig. 2 the complete circuit is from segment *7* through coils *13*, *25*, *12*, *24*, *11*, *23*, *10*, *22*, *9*, *21*, *8*, *20* and *7* to segment *13*, as described for Fig. 1. This circuit is shown by the arrowheads. The arrows have been shown dotted on parts of the coils in the slots, since these slots contain both the sides of dead and live coils, the dead side being on top. The other circuit through the winding involves coils *1*, *14*, *2*, *15*, *3*, *16*, *4*, *17*, *5*, *18*, *6* and *19*, and since this circuit is open at *X* these coils are not carrying any current.

Assume that the armature turns so that the commutator has moved one segment, then the brushes rest on segments *8* and *14*, as in Fig. 3. When the brushes move off segments *7* and *13* onto *8* and *14*, as in Fig. 3, current will be flowing through coils *2*, *15*, *3*, *16*, *4*, *17*, *5*, *18*, *6*, *19*, *7* and *20*. The open circuit will be made up of coils *14*, *1*, *13*, *25*, *12*, *24*, *11*, *23*, *10*, *22*, *9*, *21* and *8*. Comparing the circuits in Fig. 3 with those in Fig. 2, it will be seen that with the exception of *1* and *14* the coils in the dead circuit, Fig. 2, are in the live circuit, Fig. 3, and excepting *7* and *20* the coils in the live circuit, Fig. 2, have become dead coils in Fig. 3. Decreas-

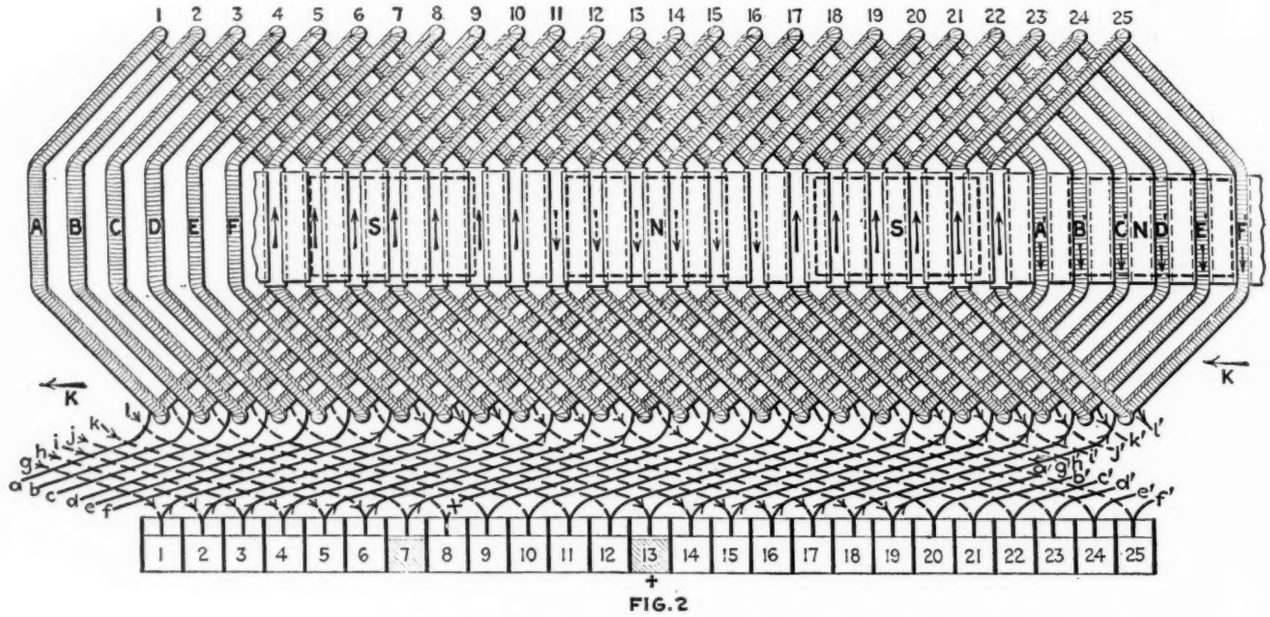


FIG. 2

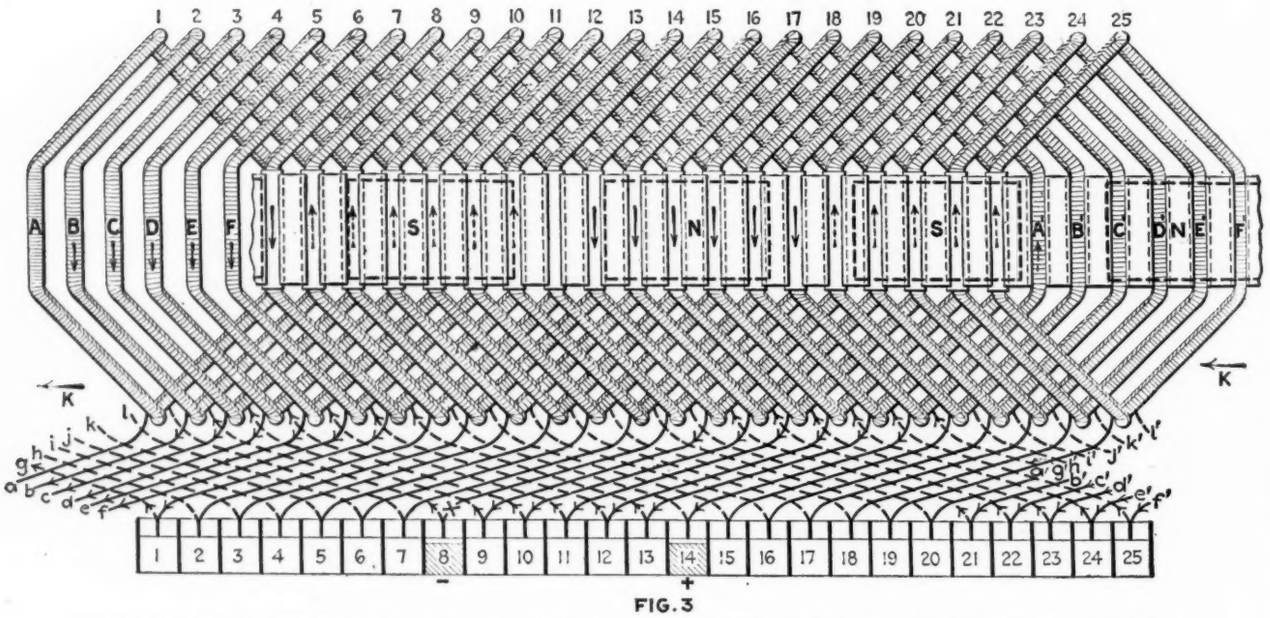


FIG. 3

FIGS. 2 AND 3. SHOWING THE EFFECT OF AN OPEN-CIRCUIT IN THE ARMATURE WINDING, FIG. 1.

ing the value of the current in practically one half of the winding and building it up to full value in the other half while the brushes pass from segment *7* to *8* causes sparking. The severity of this sparking will depend on the load on the machine. If the load is above 25 per cent the sparking will be severe, and if the machine is operated under this condition for an hour or more the commutator will be badly burned between the two segments where the faulty circuits connect.

In a parallel-connected winding only one burned spot occurs on the commutator when a coil is open-circuited. With a series-connected winding when a coil is open-circuited a burned spot will be produced on the commutator for each pair of poles; that is, for a 4-pole machine there will be two burned spots on the commutator and three for a 6-pole machine. This will be made clear by again considering Fig. 2. If the negative brush rested on segment *20* instead of *7*, the circuit through coil *14* is open just as when the brush is on segment *7*. When the brush passes from segment *20* to *21*, an arc will be created that will burn the insulation between these two segments.

Another way of looking at this is to consider only the open circuit in the winding. Two coils are involved and terminate on segments *7* and *8*. Starting at segment *7*, the circuit is through coil *1* to segment *20*, then through coil *14* to segment *8*. We can also start from segment *20* and follow through coil *14* to segment *8*, through coil *2* to segment *21*. Both these circuits terminate on adjacent segments; in the former case segments *7* and *8* and in the latter *20* and *21*. In either case, when the brushes pass the segments to which the open coil

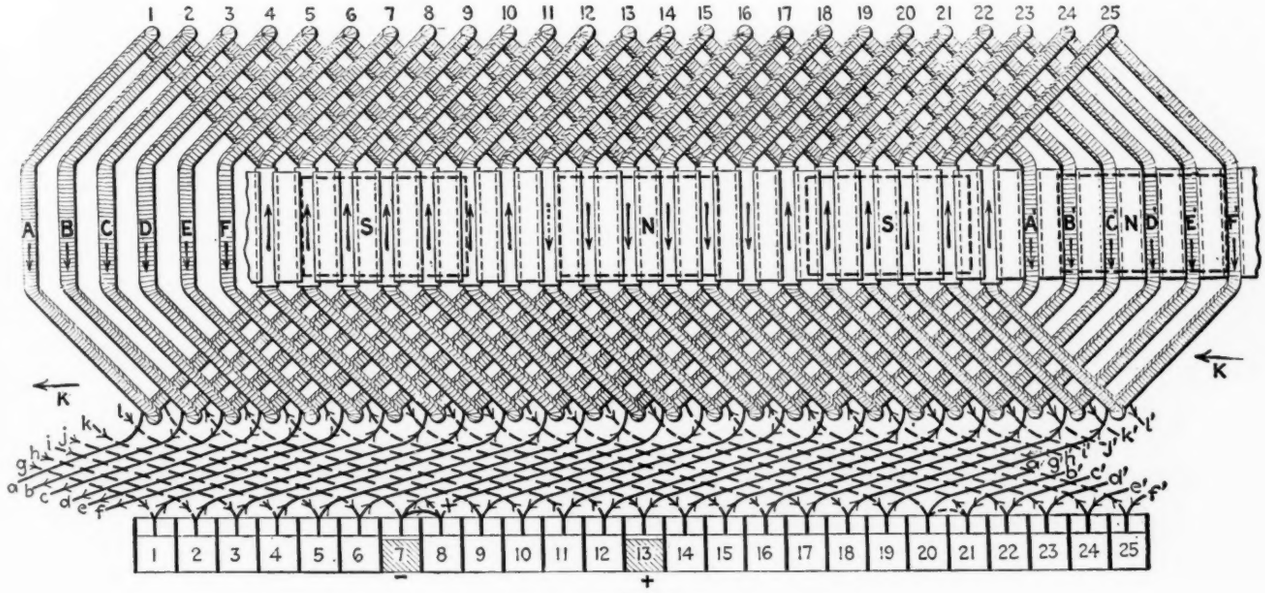


FIG. 4

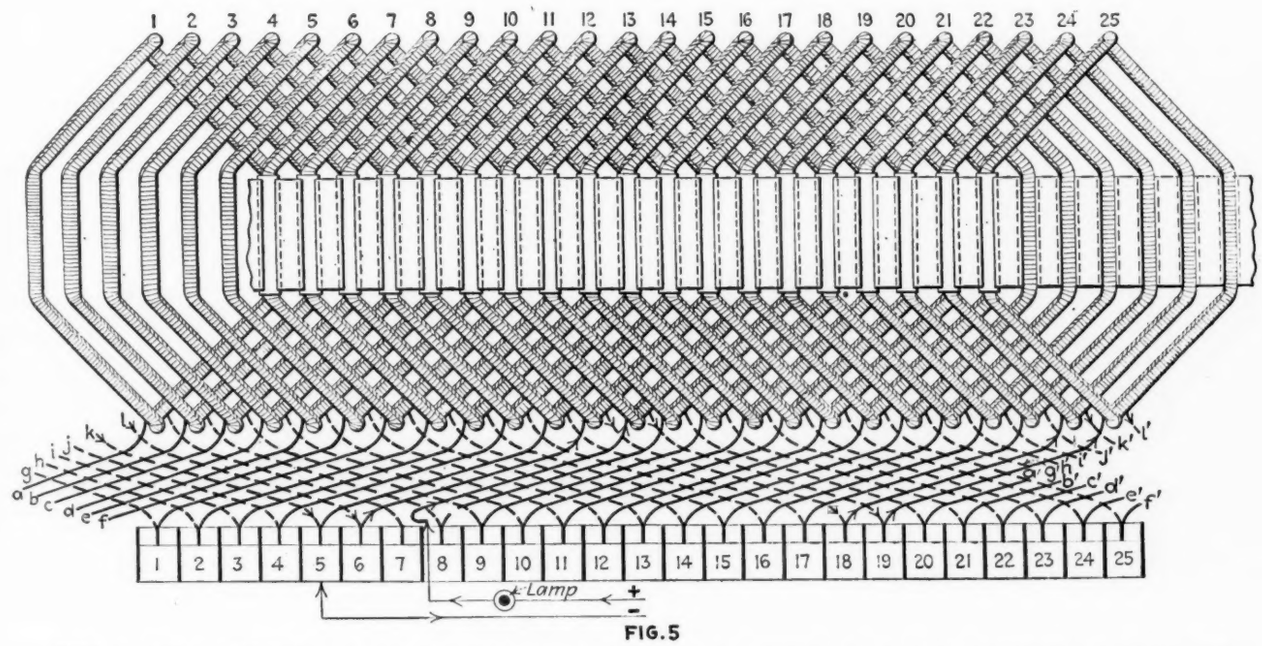


FIG. 5

FIGS. 4 AND 5. METHOD OF REPAIRING OPEN-CIRCUIT IN A WINDING AND HOW TO LOCATE A DEFECTIVE COIL WITH A TEST LAMP

is connected, a spark is produced as with the parallel winding. However, with a parallel winding only one burned spot will be produced on the commutator for an open coil, where with the series winding a burned spot is produced for each pair of poles.

In the previous article it was shown that an open circuit in a parallel winding could be repaired temporarily by connecting the two commutator segments together between which the burning occurred. In a series winding this method may be applied. However, with the series winding there will be a burned spot on the commutator for each pair of poles, but if the two segments at one of the spots are joined together the defective coil will be bridged. For example, in Fig. 4, if segments *7* and *8* are connected together, the open at *X* is shunted and the circuit through the winding that is open in Figs. 2 and 3 is closed from segments *7* to *8*, then through coils *2, 15, 3, 16, 4, 17, 5, 18, 6* and *19* to segment *13*. Thus it will be seen that coils *14* and *1* are shunted out of circuit. The open circuit in Fig. 5, and test from this lead to the commutator as shown. The circuit through this coil being complete, as indicated by the arrowheads, the test lamp will light. If the top lead in segment *8* is lifted, no light on the test lamp will be obtained from it to any segment in the commutator, since this coil is open-circuited. If the top lead in segment *20* is lifted, a light will be obtained from this lead and commutator bar *7*, but to no other. Testing from segment *20* to the other commutator bars and the coil leads that have been lifted, no light will be obtained, since the bottom lead of the open coil is connected to this segment. In this way it is found that coil *14* is the defective one and connects to segments *8* and *20*. When the top lead of the defective coil has been located, it is then known that the bottom lead of this coil connects to one of the segments at the other burned spot on the commutator.

After the segments to which the faulty coil connects are located, a jumper may be soldered to these two segments as in Fig. 6. This connection takes the place of

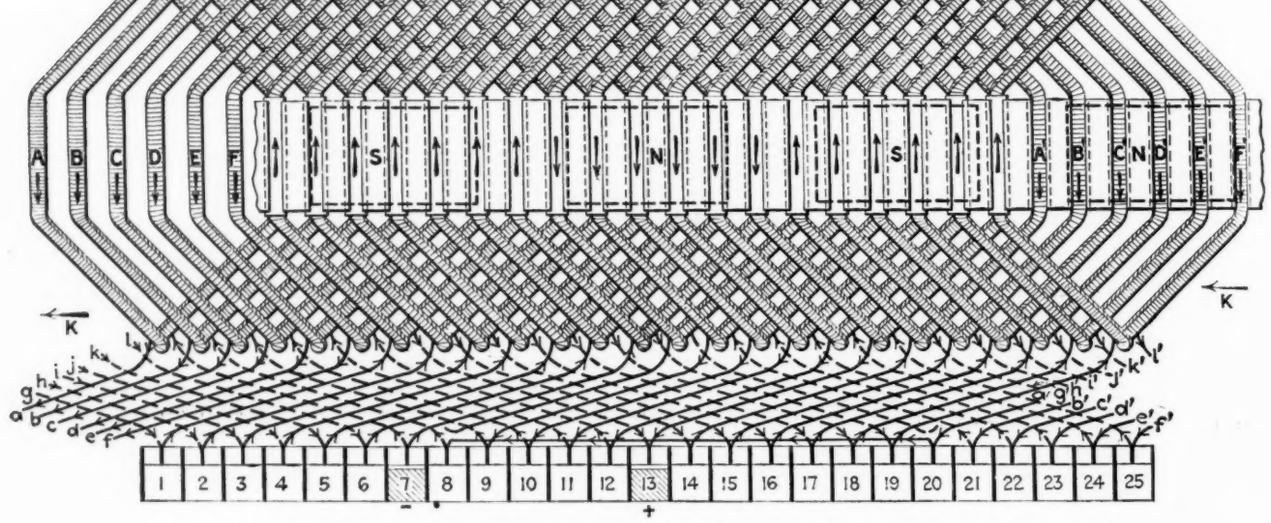


FIG. 6. HOW OPEN-CIRCUITED COIL IS BRIDGED OUT OF CIRCUIT WTH A JUMPER

could be bridged by connecting segments *20* and *21* together as indicated by the dotted line. The circuit is now from segment *7*, through coil *1*, to segment *20* and then *21*, through coil *15*, to segment *9* then through coils *3, 16, 4, 1, 7, 5, 18, 6* and *19* to segment *13*. In this case coils *14* and *2* are shunted out of circuit instead of *14* and *1*. However, in both cases the defective coil has been eliminated and the machine will operate satisfactorily. The two burned spots should not be bridged at the same time or heating will result. That is, in the figure, connect segments *7* and *8* together or *20* and *21;* either will correct the trouble.

In Fig. 4, connecting either segments *7* and *8* or *20* and *21* together cuts out a good coil. If this had been a six-pole winding, there would be three coils involved and consequently two good coils cut out of circuit. It is evident that if some means can be used to keep the good coils in circuit, it should be employed. This can be done, but it necessitates the location of the defective coil. To do this with a test circuit and lamp, unsolder the top leads on each side of the burned spots on the commutator, testing each one to the rest of the winding as they are lifted. For example, lift top lead *7*, as coil *14*, and the circuit from segment *7* is through coil *1* to segment *20* and through the jumper to segment *8*, then through coils *2, 15, 3, 16, 4, 17, 5, 18, 6* and *19* to segment *13*. It will be noted that this is the same as in Fig. 1 except that the jumper has replaced coil *14*. With this arrangement the only coil cut out of circuit is the defective one. Although this is the most desirable method, it is frequently not convenient to apply on account of the time required and the absence of a soldering iron. Therefore, out on the job where the machine must be put back into service in the least possible time, bridging two of the commutator segments at one of the burned spots will be found satisfactory.

Care must be exercised to have the jumper well insulated from the coil lead that it crosses over, since the full voltage of the machine exists between the jumper and some of the coil leads. It will also be found necessary to lift both leads of the defective coil so that the jumper may be properly soldered to the segments. The ends of these leads should be insulated and bound down with the other leads and jumper after the repair has been made. The next article will treat of the effects of grounds in armature windings and locating these defects.

The Worthington Solid-Injection Diesel

An Engine Operating on the Diesel Cycle Without Air Injection—Novel Means Employed to Secure Combustion at Constant Pressure with Pump Feed

THE solid-injection oil engine developed by the Worthington Pump and Machinery Corporation at its East Cambridge Works is a striking illustration of the success designers have had in overcoming the difficulties of producing an engine with the thermal efficiency of the Diesel, but without the expensive air compressor. While the surface-ignition, or semi-Diesel, engine does eliminate the air compressor, the disadvantages of injecting a solid stream of fuel in a large combustion chamber having walls of varying temperatures depending upon the load largely offset the advantage of airless injection and have caused designers to seek another solution of the problem of airless injection. The New Worthington engine operates on a cycle that differs from both the Diesel and the semi-Diesel principles. While the oil is pump injected it is not sprayed into a hot combustion chamber filled with the air charge, as is customary in solid-injection low-pressure engines. This latter form of injection practically compels the adoption of the Otto, or explosion, cycle, which, if it is to be efficient, must experience very high maximum explosive pressures. The engine under discussion, on the other hand, introduces the fuel into a small combustion chamber located in the cylinder head. The compression carried, being around 450 lb. per sq.in., produces a temperature sufficiently high to vaporize the fuel charge as it enters the chamber. The amount of air in the combustion chamber is so small that combustion of the fuel cannot take place. Consequently, ignition can occur only after the fuel mixes with the air charge in the working cylinder. The fuel, which is injected considerably before dead center, is vaporized, and at approximate dead center the gas or vapor resulting from the high combustion-chamber temperature experiences an increase in pressure sufficient to cause the gas to flow through the communicating orifice into the working cylinder, which at this time is at a pressure below the maximum compression, since the piston had started to retreat. The gas unites with the cylinder charge of air and burns. The diameter of the orifice is such that the gas is introduced into the cylinder at a rate that maintains the pressure behind the retreating piston at an approximate constant value of 500 lb. per square inch.

The builders claim that there are decided advantages in this gas-injection method of combustion over that usually found in surface-ignition, or semi-Diesel, engines. Since the temperature in the combustion chamber is dependent on the engine-compression pressure, the danger of misfires and irregular operation at low loads is eliminated. The temperature is at all times sufficiently high to produce complete combustion, thereby avoiding carbon deposits. The size of the combustion chamber and orifice is such that preignition within the cylinder is practically independent of the load conditions. Being completely water-cooled, the occurrence of fire-cracks in the cylinder head should be largely eliminated in this design.

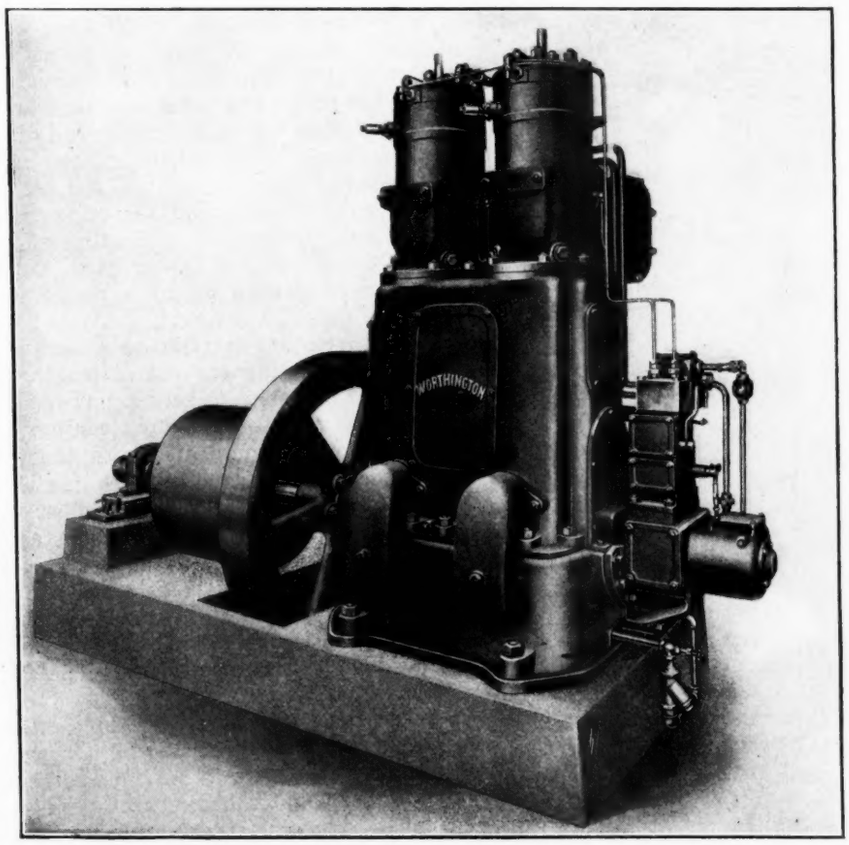


FIG. 1. WORTHINGTON TWO-CYCLE SOLID-INJECTION DIESEL ENGINE

The Worthington engine is built in one-, two- and four-cylinder units, the cylinder being either of 25, 40 or 60 hp. as required to give the desired rating. The two-cylinder, 60-hp. unit is illustrated in Figs. 1 and 2 As indicated, the engine is of the two-stroke-cycle design, using the crank or lower end of the cylinder for the compression of the scavenging air. In many respects the frame design is similar to that of a Diesel, being of the box type with large inspection doors, but it possesses the additional feature of crossheads. This, while not at all usual in small oil engines, allows a greater piston clearance and, it is claimed, will largely eliminate the wear that occurs with trunk pistons. As

shown in Fig. 2, the scavenging air enters the air compression space, which consists of cored passages in the engine frame together with the lower portion of the cylinder, through Worthington Feather valves. The size of the air passages and cylinder gives a scavenging air pressure of approximately 4.5 lb. per sq.in. This system of air compression is claimed to be superior to the usual crankcase compression, since there is no tendency for the air to leak out along the crankshaft, destroying the bearing lubrication. The amount of lubrication per horsepower-hour is equal to that secured with Diesel engines.

The crankshaft, crankpins and cheeks are formed of a one-piece forging of high-carbon steel. Where the engine is to be used for driving a generator or other machinery by belt, the driving pulley is carried on a shaft extension coupled to the flywheel end of the

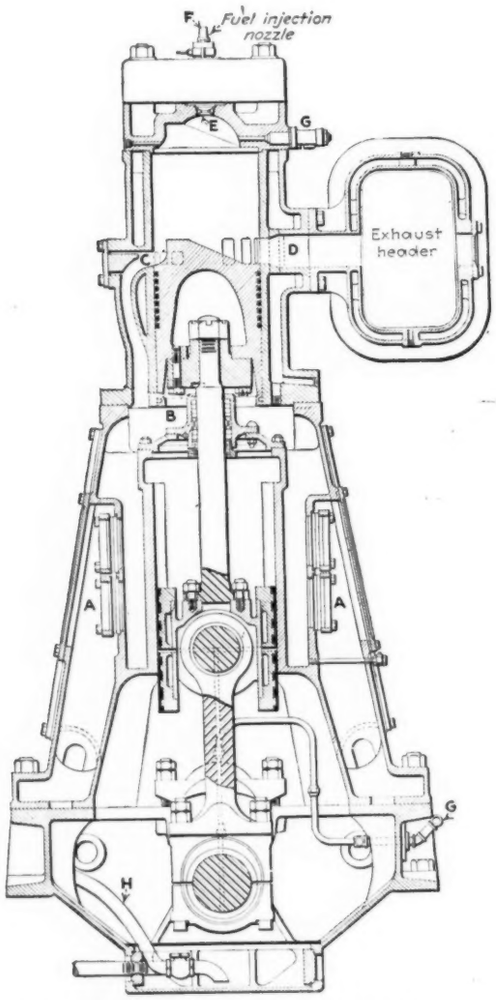


FIG. 2. CROSS-SECTION OF STATIONARY ENGINE

crankshaft, and an outboard bearing is provided beyond the driving pulley.

The connecting rod is a steel forging, with a marine-type box on the crankpin end and solid bronze bushing on the crosshead end. In adopting the solid bushing for the wristpin, the designers felt that the wristpin bearing wear was always so slight as to make the solid bushing advantageous. The crosshead is of the double bored type, the bearing surface being large so that the pressure per square inch is at all times low, and the guides are so designed and machined as to insure accurate alignment of the crosshead with the cylinder and the crankpin.

The piston rod is a steel forging, flanged at the lower end for bolting to the crosshead. At the upper end it is fitted on a taper with large shoulders to a heavy flange bolted to the piston. This rod is prac-

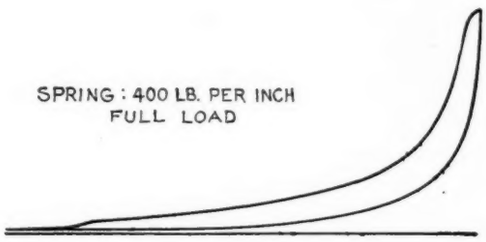


FIG. 3. INDICATOR DIAGRAM SHOWING CONSTANT PRESSURE COMBUSTION

tically always in compression, so the fastenings are but slightly stressed. The removal of the nuts securing the piston rod to the crosshead and of those securing the stuffing box to the upper end of the frame permits the removal of the piston, piston rod and stuffing box through the upper end of the engine cylinder. The piston is of the usual two-cycle deflector design. To avoid the danger of lubricating oil striking the inner surface of the hot piston head, the upper end of the piston is blanked off by a flange which supports the piston rod.

Cylinders are cast separate, each with its own water jacket extending the entire length, and bolted to the frame. Cylinder jackets are provided with four openings at the lower end for cleaning. At the upper end the jacket communicates with the water space of the cylinder head through tubes registering with corresponding tubes in the head, rubber gaskets being used to prevent leakage. The air transfer and exhaust ports are all water-cooled, as is also the exhaust manifold. The cylinder heads are designed to facilitate inspection and cleaning of water space and interior and to avoid bad metal sections that by heating might produce cracks. There are no closed, inaccessible water-jacket spaces in any part.

The force-feed system of lubrication is used for all bearings. The lubricating oil is drawn from the crankpit, and forced by a mechanically operated pump to main bearing, crankpin, crosshead pin and crosshead guides, returning to a sump below the crankpit, whence it is drawn through an easily cleaned strainer into the lubricating oil pump. The cylinder and piston are lubricated by a second mechanically operated lubricator, each cylinder being provided with two connections from the lubricator, and the oil being led into a groove turned in the cylinder bore. The two connections are on opposite sides of cylinder and are at all times covered by the piston. The eccentrics for driving the fuel pumps, the cams for controlling starting air valves, and the governor are immersed in oil.

The fuel pump, which is located in a housing at one end of the engine, is driven by an eccentric on the engine crankshaft. The pump stroke is constant at all loads, and the speed regulation is under the control of a centrifugal governor, which, by shifting a cam, varies the duration of pump suction-valve opening.

The engine gives an indicator diagram, Fig. 3, quite

similar to the usual two-stroke-cycle Diesel diagram, although the combustion line is somewhat more sloping. The falling pressure can be attributed to the slow rate of gas admission. The fuel consumption per brake-horsepower-hour ranges from 0.421 to 0.431 lb.; this is equal to the efficiency of most Diesel engines of like powers.

One interesting development that seems probable in the near future is the adoption of this design of gas injection to the automobile. Being able to operate satisfactorily at low loads and to avoid preignition at heavy loads, it would seem that the design could be easily adapted for automotive service. Since a large proportion of the crude petroleum cannot be converted into gasoline, the question of securing an engine that will handle heavy fuel oils is a vital one for the automotive industry. It is unreasonable to expect the Diesel to be used on trucks or automobiles, but the Worthington designers believe that the principle of gas injection is one that must finally be adopted.

Safety Device for Elevator Gate

BY J. E. HOUSLEY

During the year of 1919 there were thirty-four people killed in Chicago by elevators. Of this number twenty-seven deaths were due to accidents involving freight elevators, or 79 per cent of the total. This figure may vary widely in different localities, but it calls to mind that careful attention should be given to the physical

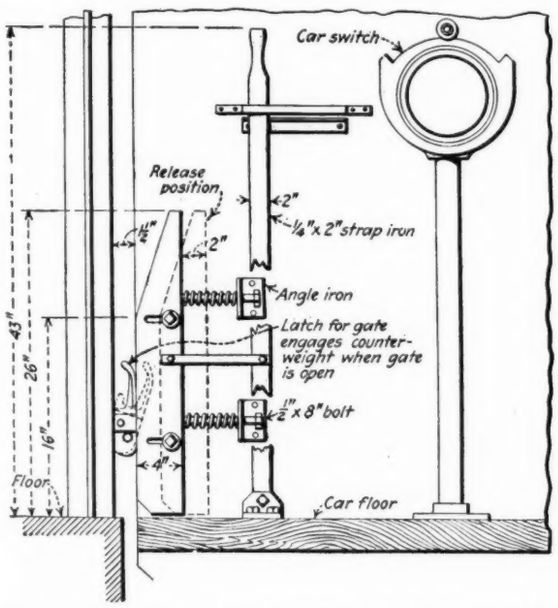


FIG. 1. GENERAL ARRANGEMENT OF ELEVATOR-GATE RELEASING DEVICE

equipment of the elevators as well as to the operating personnel.

In most industrial organizations the electrical department is usually called upon to maintain the elevator and hoisting equipment, and it would naturally follow that the electrical organization should provide for the complete protection of the persons using the equipment. In a large plant it is likely that the electrical department would work in co-operation with the safety department. It has been the writer's experience that passenger elevators are protected by devices not usually found on freight elevators. This may be because of the higher operating speed and because their prime object is handling passengers efficiently. In many cases the local organization in the plant can improve the safety features of the freight-elevator equipment.

Figs. 1 to 3 show a device that was installed on a six-story warehouse freight elevator, the object of the device being to permit the gate to be lowered before

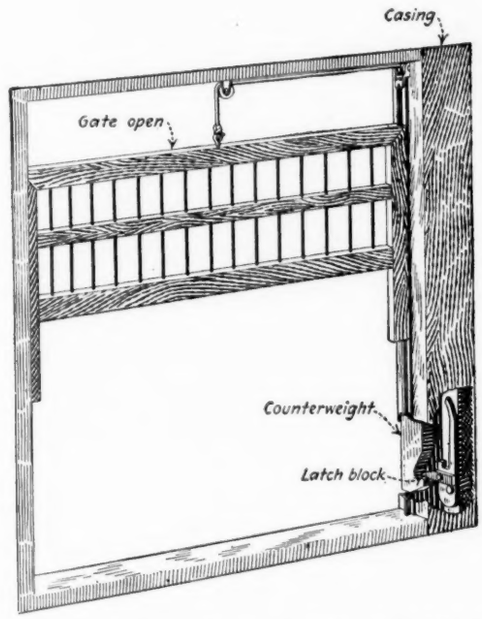


FIG. 2. ELEVATOR GATE IN RAISED POSITION, HELD OPEN BY LATCH IN COUNTERWEIGHT

starting the elevator. As originally installed, the gate closed only after the elevator moved about two feet. This gate is a counterbalanced vertical-lift type, which is largely employed in warehouses and industrial-plant buildings. The gate is shown raised in Fig. 2 engaging a latch near the floor level. In the original layout a block attached to the elevator cage held the latch in place until the car moved up or down about two feet from the landing, when the latch was released and the gate closed by gravity. To permit closing the gate before starting the car a movable block, Fig. 1, held in place on guides by means of springs was substituted. A lever attached to the block permits the latter to be pulled away from the latch about two inches and allows the gate to be closed before the elevator is started.

It has been my observation that most freight elevators are so constructed that it is impossible for the operators to know if someone is running toward the floor entrance from one side or the other of the hatchway. When persons are moving toward the elevator and it starts to move, they not infrequently attempt to board the car before it gets away from the floor. I have seen this happen many times, consequently, if the gate is closed before the elevator is started, the chances for an accident are minimized. Should the person stumble, the operator is frequently unable to prevent an accident, because the operation of the brake on most freight elevators requires over one second to bring the car to rest. During this time the elevator may move far enough to crush anyone caught by the lowering gate or allow him to drop into the shaft below.

The device shown in the figures has been in operation for several years on a large freight elevator, and it has effectively prevented any accidents from persons attempting to jump on the moving car. The only material required for this job is a block of 2- x 4-in. pine wood faced with strap iron and with two slots made in the block. Two carriage bolts, using a ⅜-in.

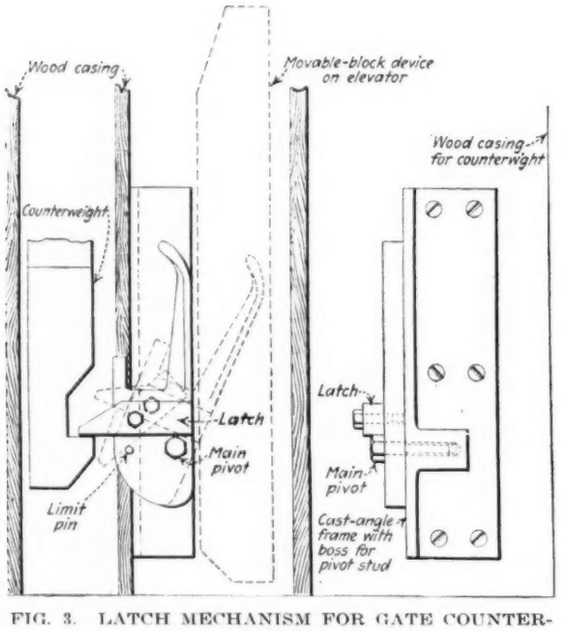


FIG. 3. LATCH MECHANISM FOR GATE COUNTERWEIGHT

On the left, side elevation. On the right, elevation looking from car.

pipe for a spacer, serve as a guide for the block. The lever is made of strap iron fastened to the floor with a piece of angle iron and connected with the movable block by a strap. The complete cost of this device installed was $10 for labor and $4 for material.

What Happens at the Expansion Valve

Engineers in the early days of refrigeration development did not fully understand the action which occurred at the regulating valve between the high side and the evaporating coils. Believing that all the ammonia liquid flashed into vapor as it passed through the valve, engineers called this the *expansion* valve; others, to express more completely their idea of the valve's function, termed it the *flash* valve. Of late years it has become more generally understood that the valve is actually a pressure-regulating device. The statement is often made that nothing but liquid passes the valve and that all the boiling or evaporating takes place in the coils. With a forecooler or accumulator it is possible, no doubt, to cool the liquid to the coil temperature and so obtain nothing but a liquid flow. On the other hand, this cooling is not secured in many plants, and an explanation of what actually takes place at the expansion valve is not amiss.

Before going into the action of the expansion valve, it is well to touch upon the behavior of ammonia under pressure. Imagine a cylinder, Fig. 1, partly filled with ammonia under a pressure of 145 lb. gage. The ammonia is at an initial temperature of 32 deg. F., and if heat is applied, by a tank of warm water for instance, the liquid ammonia will absorb heat and will show an increase in temperature until 82.3 deg. is reached. In taking up this heat, experiments prove that a pound of ammonia will show a temperature increase of one degree on absorbing 1.1 British thermal units (a pound of water absorbs one B.t.u. in increasing one degree in temperature). Upon reaching 82.3 deg. F., the ammonia no longer shows a temperature increase, provided the pressure is kept at 145 lb., but will boil, absorbing 501 B.t.u. for each pound of ammonia evaporated. If the pressure had been 100 lb. gage, the ammonia would have started boiling when it reached 63.6 deg., and the liquid would have here contained 34.9 B.t.u. per lb., this being called the heat of the liquid; and in boiling at this temperature, it would absorb 518 B.t.u. more, this being the latent heat of vaporization. It is seen that each pressure has a corresponding boiling point and a definite amount of heat is contained in ammonia liquid and in its vapor at each temperature.

In the table are shown the boiling points corresponding to various pressures as well as the heat of the liquid and latent heat of vaporization, the sum of these last two being the total heat in a pound of ammonia vapor at the several pressures.

Pressure, Lb. Gage	Temperature, Deg. F.	Heat of Liquid	Heat of Vaporization
175	92.7	68.6	490.0
145	82.3	56.2	501.1
125	74.5	47.3	508.6
100	63.6	34.8	518.8
60	41.3	10.3	538.5
46.5	32.0	.0	546.4
30	17.4	−15.3	558.4

It is noticed tnat at 46.5 lb. the boiling temperature is 32 deg. and tha. the liquid is assumed to possess no heat. This is for the reason that 32 deg. is taken as the starting point, and since we are interested in the absorption of heat, it makes no difference where the

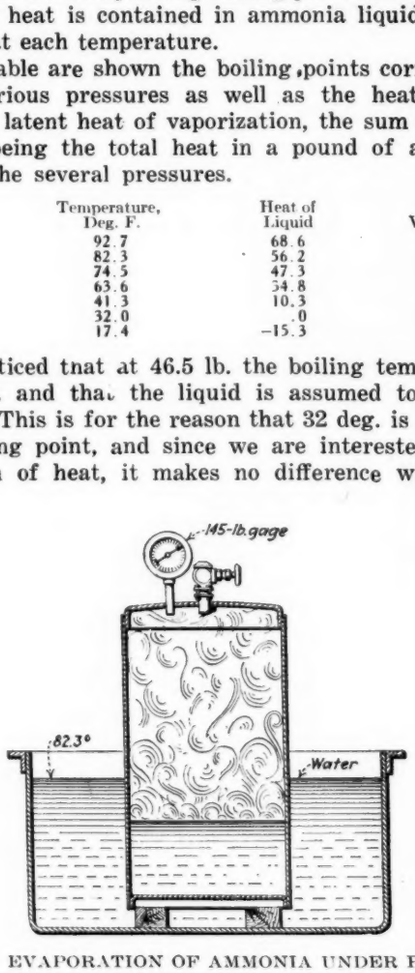


FIG. 1. EVAPORATION OF AMMONIA UNDER PRESSURE

base or starting point is taken. For this reason at 30 lb. and 17.4 deg. the heat of the liquid is —15.3 B.t.u. when 32 deg. is taken as the no-heat base. At each pressure there is a corresponding temperature at which the ammonia liquid will boil and, in so doing, must absorb heat, since the evaporation cannot take place without the addition of heat.

Suppose enough heat is added to just raise the temperature to 82.3 deg., now let the valve on the cylinder be opened and the pressure allowed to drop from 145 to 100 lb. The ammonia that is in the cylinder at 82.3 deg. has not boiled away since the application of heat was discontinued. Each pound, however, contains 56.2 B.t.u. at 82.3 deg., and none of this is lost when

the pressure drops to 100 lb. But the table shows that the boiling temperature at 100 lb. gage is 63.6 deg. and at 63.6 deg. each pound of liquid contains 34.8 B.t.u. As shown, each pound contains 56.2 B.t.u. at 145 lb., and no heat is lost when the pressure drops to 100 lb. There is, then, an excess of 56.2 — 34.8, or 21.4 B.t.u. The effect of this extra heat above the heat of the liquid at 100 lb. is the same as if the same amount of heat was applied from the outside. It will cause some of the ammonia to boil. Since one pound of ammonia at 63.6 deg. and 100 lb. pressure requires 518.8 B.t.u. to evaporate for each pound of liquid, only $\frac{21.4}{518.8}$, or 4.1 per cent of each pound, can be evaporated by the excess heat in the pound when reduced in pressure from 145 to 100 lb. Likewise each successive reduction in pressure allows more of the ammonia to evaporate.

Applying this to the expansion valve, there is on one side, Fig. 2, a receiver and line pressure of, say, 145 lb. gage. On the other side the coil pressure is 46.5 lb. gage, the coil temperature being 32 deg., while between the two pressure sides is interposed the expansion valve. It is so set that the pressure in the coils is maintained at 46.5 lb. gage. It is apparent that while the pressure on the high side is 145 lb. and on the other side 46.5 lb., the pressure through the valve is a gradual reduction from 145 lb. The valve could be replaced by a small pipe of the proper diameter to give a flow into the coils sufficient to keep the pressure constant while the compressor receives the vapor as it is generated. In Fig. 3 the valve is replaced by such a pipe, and at the entrance 145 lb. pressure is registered. At *a* the pressure drops to 125 lb. Here, as shown in the table, the heat of the liquid at 125 lb., and 74.5 deg. F. is 47.3 B.t.u., while the ammonia actually contains 56.2 B.t.u., the heat of the liquid at 145 lb. The excess 56.2 — 47.3, or 8.9 B.t.u., is employed to evaporate a part of the ammonia. As the liquid and small amount of vapor continues along the pipe, it drops in pressure and at *b* the gage shows 60 lb. The boiling temperature at this point is 41.3 deg. F. and the heat of the liquid is 34.8. The difference of 47.3 — 34.8, or 12.5 B.t.u., is used in evaporating a further portion of the liquid. The action continues to the exit into the coil, where at 46.5 lb. the boiling temperature is 32 deg. and the heat of the liquid is 0 B.t.u. At 32 deg. all the heat of the liquid at the receiver pressure and temperature has been used to evaporate part of the ammonia and a mixture of liquid and ammonia enters the coil. Since the heat of evaporation is much more than the heat of the liquid, only a minor portion of the ammonia is a vapor when entering the coils.

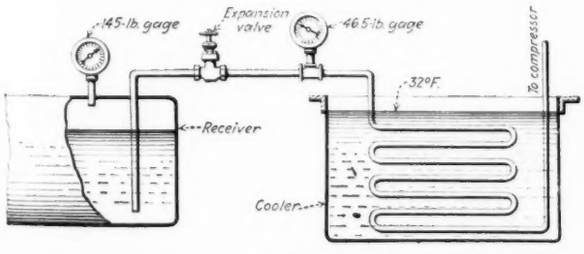


FIG. 2. REFRIGERATING SYSTEM WITH EXPANSION VALVE

The heat that the ammonia can remove from the cooling room at 32 deg. is evidently the difference between the total heat of evaporation at the suction pressure and the heat of the liquid at the receiver pressure, or in the form of an equation it could be expressed as $Q = L_2 - h_1$, where L_2 is the latent heat at the coil pressure, and h_1 is the heat of the liquid at the receiver pressure. It happens that suction pressures other than 46.5 lb. are used; even 60 lb. could be used. At this pressure the heat of the liquid is 103 B.t.u. so all the heat of the liquid at the receiver pressure is not used to boil part of the liquid; as the liquid at 60 lb. contains some heat of the liquid, only the differences of liquid heats is so used, or $h_1 - h_2$. The heat absorbed from the coolers is then $Q = L_2 - (h_1 - h_2)$. If the coil pressure is less than 46.5 lb., say 30 lb., h_2 is a negative quantity, and using the values in the table $Q = 558.4 - [56.2 - (-15.3)]$ which becomes $Q = 558.4 - (56.2 + 15.3)$ or 486.9 B.t.u.

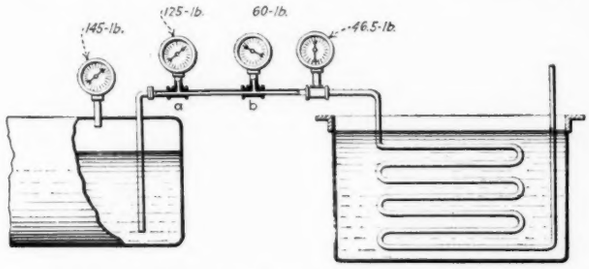


FIG. 3. PRESSURE DROP BETWEEN RECEIVER AND COILS

Defective Controller Caused Motor To Burn Out

BY B. S. BAXTER

Not infrequently, owing to some defect in the controller or otherwise, motors are overloaded and burned out without anyone giving consideration to the real cause of the failure. A case in mind is the burning out of a 1-hp. polyphase induction motor that was used to drive a small pressure pump. It was rewound and put back into service and failed again in about two days. The man who rewound the machine got the blame for poor workmanship, and the machine was again rewound by another winder and put back into service but within two days the winding was again roasted out.

By this time it dawned upon someone that there might be some defect in the control equipment or elsewhere that was causing the trouble. An examination disclosed that the automatic pressure switch was out of order, due to a choked pipe. The switch, failing to operate, allowed an excess pressure to be built up and overload the motor, causing it to burn out. The motor was rewound for the third time and started up after the switch had been overhauled, and no further trouble was experienced.

A thorough investigation as to the cause of the burn-out in the first place, and a test of the motor under load to determine the exact load conditions would have saved the cost of rewinding the motor twice and the inconvenience of having the machine out of service during these periods.

Power-Plant Accounts—VIII. Considerations in Buying Equipment—Meaning of Depreciation

BY WILFRED A. MILLER

AMONG the elements of indirect cost of power we sometimes find the item of obsolescence, as pointed out in previous articles. Obsolescence, as explained, comes from the word obsolete. It is used to express the diminution in value of a piece of apparatus due to the fact that more efficient or economical apparatus of the same kind has been put on the market since the time when it was installed.

So far as cost of generating power is concerned, obsolescence may be considered as an element of such cost only when it can be predicted with some certainty that apparatus is going to become obsolete within a limited period of time. When no basis for such an assumption exists, there should be no charge for obsolescence. The concern may set aside a certain sum each year out of its profits as a reserve against such a contingency, but such a reserve would be in the nature of insurance. The concern is insuring itself against the possibility that someone will invent apparatus so superior to that which it is using that it will have to scrap its old equipment and install the new if it wants to keep up with its competitors. The difference between the case in which we enter obsolesence as an expense and that in which we make provision for it only as a reserve against a contingency, is that in the one case it is a probability and in the other only a possibility. In the first case it is almost sure to happen, in the second it is very unlikely to do so. If it doesn't, we are just that much ahead of the game. We can take the money we set aside for the purpose and distribute it as an extra profit.

Whether we have made provision against obsolesence either in one way or the other, or whether we have made no provision for it at all, it is quite likely that we shall be called upon from time to time to make a decision regarding the replacement of certain pieces of apparatus. That is, irrespective of any allowance for obsolesence, we may feel it necessary to buy some new piece of equipment to replace an old one now in use. As a matter of fact such replacement may not be made necessary as the result of obsolesence at all. It may be due to depreciation. That is, a piece of apparatus may be so badly worn that we feel it will be better to throw it out and buy a new one to go in its place. The new one may even be of the same design as the old. The point to be brought out is that replacements of various kinds are, without question, necessary from time to time. Whether such a replacement is made necessary due to obsolesence or to depreciation, either natural or abnormal, does not alter the fact that replacement has to be made. The fact is that, whatever the cause, the matter is brought before us for a decision. The question is, how are we to arrive at a decision? What factors must be taken into consideration? Suppose we take these up one at a time.

This is the eighth of a series of articles written in conversational style and treating the subject of power-plant accounts in a thorough, yet simple manner. They were prepared primarily for the guidance of the operating engineer who wishes to keep track of the cost of the power he is making, but who knows nothing at all about bookkeeping. Others may find the articles helpful in clearing up their ideas on the subject. This installment starts by reviewing part of what has gone before and then discusses the financial considerations that determine the selection of new equipment. This is followed by further consideration of the meaning of depreciation from a financial point of view.

First, we may have obsolesence as a cause of the suggested replacement. The apparatus may be only a few years old, and therefore not much of it has been used up; that is, the depreciation charged to the cost of power may be only a small part of the value of the apparatus, so that it is worth to us almost as much as we paid for it. Now a salesman comes along and exhibits figures to show that we can save a lot on labor, or on steam, or on current, as the case may be, by installing some new apparatus. We must then ask ourselves, "How much is this going to save us in a year?" After figuring it out, let us suppose that we find it amounts to $200 a year. Also let us assume that the value of our apparatus when new was $1,000 and that we have allowed $100 depreciation on it, so that it is actually worth 1,000 — 100 = $900. Upon consulting a second-hand dealer, we find that he would allow us $300 for it, according to which we would stand to lose 900 — 300 = $600 on the old equipment. The more efficient apparatus which the salesman is presenting to us costs $1,350. To this we will have to add the $600 that we would have to sacrifice on the old equipment if we put in the new. We must do this because we have really put in two machines to do the work of one, as we figured that we could save money by doing so. Therefore we have to consider the cost of the two together to find out what it costs to operate this particular unit of the plant. Moreover, we estimate that it is going to cost us $50 to take out the old and put in the new, so we will have to add that in, too. The total investment in the new apparatus would therefore be 1,350 + 600 + 50 = $2,000. We figure that, although its efficiency is higher than the old one, it will last only 10 years as compared with an estimated life of 20 years for the old apparatus. If we use the method of determining depreciation in which we "write off" the same amount each year, we find that our depreciation on the new unit will be $\frac{2,000}{10}$ = $200 per year, whereas on the old it is only $\frac{1,000}{20}$ = $50 per year. From this it is evident that our cost of generating power will be jacked up by an amount equal to 200 — 50 = $150 per year if we put in the new equipment. We have, however, already figured that it is going to save us $200 a year to put it in. Consequently, we are going to show a net saving of 200 — 150 = $50 a year if we

put the deal through. On the face of it therefore it would seem all right to do so, since there is no question but that we are going to save money by it.

Before we put our O.K. on it, however, let us stop a moment and think over just what it all means. To put in the new outfit is going to cost us in actual cash $1,350 for the unit + $50 for installation = $1,400. By spending this amount of money, we will be able to save $50 per year on our power cost. Is it worth while? Let us see. A saving of $50 per year on an expenditure of $1,400 means that we are earning how much interest on our money? The answer is, of course, $\frac{50}{1,400} = 0.035$ approximately, which we multiply by 100 to convert it into percentage, so that we have $0.035 \times 100 = 3.5$ per cent interest per year. This rate is not sufficient to justify us in throwing out the old unit. It would have to be considerably higher than that before we would consider such a thing. Just look what we could do! We could take the $1,400 that it would cost us to make the change and invest it in a perfectly safe way in such a manner that it would certainly not give us less than 5½ per cent. At this rate we would be getting $1,400 \times 0.055 = \$77$ interest each year. Suppose we subtract this from what it costs us to operate the old unit. We know that it costs us $200 more than it would to operate the new one. Subtracting from this $200, the interest that our $1,400 is earning, we have 200 — 77 = $123. This is the amount that it would cost us extra to run the old as compared with the new if we used the $1,400 to earn interest. If we used it to buy the new outfit, we would have an extra cost for depreciation of $150. Hence the new unit would actually show a loss of 150 — 123 = $27, as compared with the interest method. Consequently, if we had the $1,400 to spend, we would do better to invest it than to sink it into the new equipment.

The question may be raised, If we did not have the $1,400 to spend, what would the condition be then? Let us suppose such a case. Since we haven't the money, we would have to borrow it. Probably we should have to pay at least 6 per cent interest on it, which would cause us an expense of $1,400 \times 0.06 = \$84$ per year. This would have to be added to our $150 depreciation on the new unit, giving us 84 + 150 = $234. The saving we can make by putting in the new equipment is only $200, so that if we were actually to put it in we should expect to lose 234 — 200 = $34 per year. If we could borrow the money at 5½ instead of at 6 per cent, our result would be, $77 interest + $150 depreciation = $227 total per year, and our loss on the transaction 227 — 200 = $27 per year. It will be noted that this corresponds with the amount of loss which we determined in the case where we assumed that we had set out our $1,400 at 5½ per cent interest instead of putting it into the new equipment.

There is still another way of handling this problem, and that is this: Instead of adding the $600 that we would lose on the sale of the old unit to the price of the new, we could set it aside as a loss on our investment. This we could do by making a journal entry of $600 to Investment, placing the $600 in the right-hand column. Under these circumstances our cost for the new outfit would be only 1,350 + $50 for installing = $1,400, and the depreciation would then be $\frac{1,400}{10} = \$140$ per year instead of $200 as by the other method. Hence the difference between the new and old depreciation would be 140 — 50 = $90 instead of $150 as before. Since $200 is going to be saved by the use of the new outfit, the net saving to us will be 200 — 90 = $110. This, on an investment of $1,400, would show a return of $\frac{110}{1,400}$ = 0.08 almost, or practically 8 per cent.

This would seem to justify us in installing it, but if we did authorize it, we would be losing sight of the fact that we have suffered a loss of $600 to put through this new scheme. Are we justified in taking such a loss? Let us see. For ten years we would be making a net saving of $110 a year, or 10 × 110 = $1,100 for the ten years. But we took a $600 loss to start with, so our net saving is really only 1,100 — 600 = $500 for the ten years, or $50 a year. Thus we get back to exactly the same point as by the other method. That is, we are making a final net saving of only $50 a year on a cash outlay of $1,400, which is not a sufficiently attractive proposition to interest us, since we are getting a return of only about 3½ per cent on our money, whereas we could get at least 5½ in other ways.

Other Factors to Consider

In studying problems that involve obsolesence, there are sometimes other factors to be considered than those that relate directly to the saving effected by the apparatus itself. The following illustration will serve to bring out a not unusual case of this kind. We are operating a power house consisting of a boiler room and an engine room in neither of which we have any space available for new equipment. The boilers are hand-fired on natural draft, and the prime movers are reciprocating engines driving electric generators. All the equipment is in first-class condition, but is being run to the limit of its capacity. It now develops that the company is contemplating an addition to its works that will entail a demand for about 50 per cent electric power in addition to that which we are already generating. To furnish this from our present equipment is an impossibility since we are already loaded to capacity. The only solution, therefore, appears to be the installation of additional equipment, and since we are already crowded in our present quarters with what we have, it will be necessary to erect new buildings for the purpose.

When we come to this stage in our plans, we find that we have no ground available for the purpose. Our station is down at a boundary line of the property and is so closely surrounded on its other sides by buildings of the factory that there is nowhere room to build the proposed extension. We know that we can buy some of the property adjoining the station, but it is being held at a rather high price. Before we decide to recommend purchasing it and erecting the new station thereon, it may pay us to look at the problem from an entirely different point of view. We have been looking into the matter of turbine units for some time past, thinking that maybe it would pay us to replace our engine-driven units with them. However, after careful figuring we found that what we could save in steam would not begin to make the change worth while.

Of course, when it comes to our new station, there would be no question about it; it would surely be turbine units. Why? Well, first off, they use less steam per kilowatt-hour, and then look how much less space they occupy! Look what you can save on the building alone! Here it occurs to us that if we only had turbine

units in our present plant instead of the engines, we would have plenty of room and to spare. This leads us still further. How would we stand if we threw out the engine units and put in enough turbine capacity to take care of not only the old load, but the new as well? Here we begin to do some extensive figuring. By the time we get through, we have some interesting results to show to the management.

Purchase of Land Avoided by Use of Turbines

We find that by ripping out two of the old units, we can make enough room to put in an amount of turbine capacity that will take care of the load the replaced engine units carried and in addition to that all of the new proposed load. Better yet, there will be enough space left to allow of some further expansion in the future. And all this can be done at a figure materially less than what it would cost us to buy additional ground and erect a supplementary plant on it, even after making full allowances for the scrapping of the engine units. Of course it will be a rather narrow squeak to get the first turbine unit in. It will have to be installed during the season of the year when our load is lightest, so that we will not have to overload our engine units any more than absolutely necessary during the transition period. Obviously, we cannot help overloading them for that time because we will have to rip out one of the units to make room for the first turbine set. After that, however, we will have easy sailing.

So far so good. But what about our boiler plant? We're talking a lot about not having to buy any more property for our engine room, but what have we to say about the boiler room? Won't we have to buy the ground anyhow, so as to have room for additional boiler capacity? That looks like a sensible question, but it does not stump us at all. We have known for a long time that we could get more out of our boilers by putting in mechanical stokers and forced draft, but we never did it. We could make all the steam we needed with our present equipment, and the economy effected by making the change would not pay for the additional investment. So we never went in for it. Now, however, the situation is entirely different. By making the change, we find that we will be able to make all the additional steam required for the new load and that the cost of making the change will be only a fraction of what it would cost to put up an additional boiler plant. Hence our problem solves itself very simply.

All Factors Must be Considered

In the foregoing we have an illustration of the fact that there may be rather complex factors to be considered when it comes to a decision as to whether old apparatus is to be abandoned or not. In our particular example the obsolesence of the engine units was not such as warranted replacing them with newer units merely as a matter of economy in generating power, but when the factor of land space and building was introduced by proposed expansion, it was then found to be a paying proposition to scrap the old units in spite of the fact that they were in splendid condition and operating at high efficiency. Likewise a mere increase in efficiency in boiler operation did not warrant the expenditure required for stokers and draft equipment so long as the steam demand was at its old value. But the minute greater steaming capacity was demanded, the investment required proved to be a very profitable one.

Enough has probably here been said to point out the necessity of making a careful survey of every problem as it arises, in order that the solution arrived at shall prove to be the most economical one in the end.

Power-Cost Determination

Considerable stress has been laid on the fact that such items as depreciation, taxes, interest, insurance and obsolesence are elements of indirect cost in the generation of power. That they are so has been definitely proved. When it comes to such things as taxes, interest and insurance, it is easy to see how they are an expense, because we actually pay out good money for them. In the case of depreciation, however, and also that of obsolesence, it is not so easy to see this. We have convinced ourselves that they are items of expense, but it is hard to see just how we pay for them. Let us look into this phase of the subject a little.

As a simple illustration we will assume that for $10,000 we have bought an engine that we expect will last for 25 years. If we use the system of depreciation by means of which we write off the same sum each year, we find that our depreciation amounts to $\frac{10,000}{25} = \$400$ per year. We enter one-twelfth of this in our journal every month, so that at the end of the year we find that we have the $400 correctly charged to depreciation. For the sake of our argument let us permit ourselves to imagine that depreciation of the engine is the only cost of generating power that we had during the year. That is, let us take an imaginary case in which we do not have to pay anything for labor, coal, or anything else. Further, let us suppose that after buying the engine we had $5,000 left in the bank. When the end of the year rolls around we find, in accordance with our imaginary conditions, that we have paid out none of our money in the bank. Our books show that our only expense has been $400 for depreciation. So we find that we have both our engine and our $5,000.

Tax Expense More Evident than Depreciation

This is a condition quite different from the one we would find if we had entered such an expense as taxes, for instance. Thus, suppose that instead of depreciation being our only expense, we had also had an expense of $200 for taxes. These we should of course have been compelled to pay, so that we would have had to spend some of our money in the bank. That is, instead of having $5,000 in the bank at the end of the year, we would have had only 5,000 — 200 = $4,800 left. Hence in this case we would have our engine as before, but only $4,800 in the bank. We are therefore poorer by $200 than we were at the beginning of the year, owing to the taxes we have paid. But in the case of depreciation alone we were not a bit poorer at the end of the year than at the beginning. So how can we say that we had any expense for depreciation?

There are two points to be brought out here. In the first place we are wrong in saying that we are no poorer at the end of the year than at the beginning. We are poorer. At the beginning of the year we had $10,000 worth of engine and $5,000 worth of cash in the bank. During the year we used up $400 worth of engine. We would quickly have found this out if we had tried to sell it. We would find that we could not get $10,000 for it any more. Having been used for a year, it would be worth less than that, in fact $400 less, so that all we could expect to get for it would be 10,000 — 400 = $9,600, even if the buyer were willing to pay

the full value. It is therefore clear that at the end of the year we are worth only $9,600 worth of engine + $5,000 in cash = $14,600 total, whereas at the beginning of the year we were worth $10,000 + $5,000 = $15,000 total. We now see that we were fooling ourselves when we said we had no expenses during the year just because we didn't pay out any money for them, but we don't yet understand just what does become of that $400 expense. To do this we must proceed to the second point in the discussion.

The second point to be made is that all business is conducted for the purpose of making a profit. In order to make a profit on our business, we must charge enough for what we sell to pay us for all our expenses and a little extra. Let us consider our example of the $10,000 engine. We found that if we paid taxes we would be poorer by $200 at the end of the year than at the beginning; that is, $200 poorer in cash. If we were to take depreciation into account, we would really be poorer by $200 for taxes + $400 for depreciation = $600 total. However, let us consider the taxes only for the time being. We are poorer by $200. Next year we shall be poorer by $200 more; that is, by $400 altogether. This will keep on until at the end of 25 years our $5,000 will have vanished. With such a prospect in view we might as well get out now and save what we can.

What all this means is that someone, somehow, has got to pay us at least that $200 to allow us to keep ourselves afloat, even without making a profit. The question is, Who is going to pay the $200? If we were operating a central station—that is, a public-service station—the answer would be quite simple. Naturally, the company's customers would pay it. In actual practice they pay all the expenses and, as remarked a little while back, something to boot for profit. But for the man who is operating an isolated plant the answer is not so simple. Let us see whether we can discover it.

Power Plant is a Manufacturing Department

Our power plant is a part of the factory as a whole. The only way that we or any other department can get any money is from that which is paid to the factory by the people who buy what it manufactures; that is, from its customers. In order for the factory to "carry on," it must charge its customers at least as much as the cost of manufacture, and to prosper it must charge something extra for profit. Now what is the cost of manufacture? The readiest answer is, the cost of the material and the labor for manufacturing it. That is quite obvious, but there are many additional items. Just as we found direct and indirect elements of cost in the generation of power, so we find direct and indirect elements in the manufacture of the article or articles that our factory turns out. One of these elements is power. So it is apparent that the source from which we derive the money to pay our power-house expenses is the customers who buy what our company manufactures. It is a more indirect way of collecting for our power than in the case of a public-service station, but the money comes in just the same.

The greatest difference between ourselves and the central station is this: The central station sells its power for a certain fixed price depending upon the class of service. They get this price no matter what it costs them to generate the power. Hence, the cheaper they can turn it out the greater will be their profit. In our case of the isolated plant, however, we have no fixed price. It is our job to turn out power as cheaply as we know how. Whatever it costs, the firm pays. On the other hand, we never show any profit or, for that matter, any loss. Having no fixed price at which to sell our power, this would naturally be the case. A little later on we shall try to develop a scheme by means of which this condition will be remedied, one by which we shall be allowed to charge a fixed rate to the rest of the factory. But for the time being we will content ourselves with dealing with the conditions as they exist in the vast majority of the establishments.

Depreciation a Real Expense

We can now come back to a consideration of our original problem relative to the engine that was bought for $10,000. We have seen that, in order for us to survive, our expenses must be paid for by someone. Consequently, we shall take it for granted that the $200 a year that we are paying for taxes is being paid back to us by whoever is using the power that our engine generates, whether the payment be made directly or indirectly. Now at the beginning of the year our cash in bank was $5,000. After we paid our taxes it was $5,000 — 200 = $4,800, and after we were paid back this money by whoever it was that paid it, our bank account became 4,800 + 200 = $5,000; that is, the same as at the beginning of the year. So we see that we are even on that score. Now, however, we must take into consideration the depreciation on our engine. We have used up $400 worth of it in the year and somebody has to pay us for it. This means that instead of being paid $200 for taxes alone, we must be paid an additional $400 for depreciation of our engine. Our bank account will then be 5,000 + 400 = $5,400. Thus, at the end of the year we have more money than we had at the beginning and it therefore looks as if we had made a profit, but the actual conditions are these:

At the beginning of year, engine $10,000 + cash $5,000 = total $15,000. At end of year, engine $9,600 + cash $5,400 = total $15,000. So, after all, we are no richer at the end of the year than we were at the beginning.

At the end of 25 years the condition would be this: The engine would be worth practically nothing; that is, just scrap. We would have collected $400 each year for depreciation. For the 25 years this would have amounted to 25 × $400 = $10,000. This added to the $5,000 cash with which we started would give us 5,000 + 10,000 = $15,000 in the bank. Hence the conditions would be:

At time engine is new, engine $10,000 + cash $5,000 = total $15,000. At end of 25 years, engine scrap × cash $15,000 = total $15,000. We thus see that at the end of the 25 years we would have back the $15,000 we originally set out with.

Capital Consists of Equipment as Well as Money

We started out with $15,000 in money. That is, our capital was $15,000. After buying the engine for $10,000, we had only $5,000 left in money, but our capital was still $15,000. It was merely divided into two parts —engine, $10,000 and money, $5,000. At the end of the first year our money had shrunk to $4,800 due to the fact that we had sliced off part of our bank account to pay taxes. Also, at the end of the first year our engine had shrunk to $9,600. This was due to the fact that at every stroke of the piston and crosshead, at every revolution of the flywheel, at every movement of the valves, a little bit of the engine was being sliced away.

At the end of the year this slicing had reached such proportions that of a $10,000 engine only $9,600 worth was left. The taxes we settled for in cash in one lump sum. Our $5,000 lay quietly in the bank until we came along and took part of it away. But not so our engine. It wouldn't stay put. Minute by minute, hour by hour, it kept sneaking off in little bits. So we didn't have to bother about paying for depreciation the way we did for taxes. The engine saved us that trouble; it "paid away" itself. So our money capital shrank because of tax expense, but our engine capital shrank on account of depreciation. Our total capital, therefore, shrank by the amount of the two combined, and what was left of it at the end of the first year was $4,800 cash + $9,600 engine = $14,400. As far as our total finances are concerned, we are just as poor as we would be if we had spent $400 in cash for depreciation instead of $400 in engine. Thus, if someone could have come to us and said, "If you will pay me $400 instead of allowing your engine to depreciate, I will keep it brand new," and if we had accepted the proposition, we would have paid the $400 for depreciation in cash instead of in engine. In that case we could have seen very clearly that depreciation is an expense that is being paid for. Just because we are paying in engine instead of in money doesn't make any difference. As we have just seen, our total capital amounts to the same thing either way. The only difference is that the form it takes in one case is somewhat different from that which it takes in the other.

What applies to depreciation applies with equal force to obsolesence. Although entirely different in origin, these two classes of expense are so closely related in their effects that the same reasoning is true in both.

Small Engine Foundations

By H. BLOMGREN

IT FREQUENTLY happens that it is necessary to install a new engine or pump, and as the foundation for this apparatus is usually furnished by the purchaser, the power-plant force is often called upon to build it. The manufacturer furnishes the purchaser with a blueprint of the foundation plan of the unit that he is to furnish, which shows the various parts of the machine to be supported, also the sizes and location of the foundation bolts.

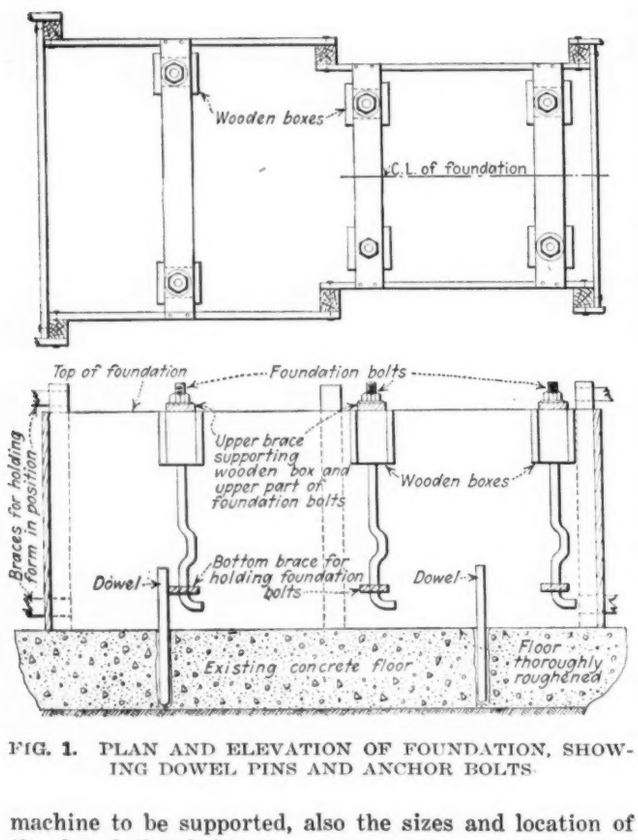


FIG. 1. PLAN AND ELEVATION OF FOUNDATION, SHOWING DOWEL PINS AND ANCHOR BOLTS

After the location of the machine has been determined and if there happens to be a good, thick concrete floor where the new foundation is to be built, the measurements of the bedplate should be chalked out on the floor and this area thoroughly chipped and roughened up, removing at least one-half inch of the old surface to assist the new concrete foundation in making a bond to the old concrete floor. Holes are also to be drilled in the floor for dowels by means of a star drill. The number of dowels varies with the size of the foundation, but two to six are usually sufficient. The holes should be drilled large enough for 1-in. dowels, and they should be long enough to allow them to project into the old concrete to a depth of at least 9 in., and also up into the foundation proper the same distance, as shown by Fig. 1. In case the concrete floor is not strong enough to act as a footing in distributing the load over a sufficiently large area, it will be necessary to rip out that portion of the floor and excavate deep enough to prevent the engine from settling. The distance from the general floor level to the bottom of the foundation should never be less than 3 ft., and it is advisable to carry the foundation down at least 5 to 6 ft, for small foundations. Foundations for large engines are sometimes carried down 20 to 25 feet.

On account of the low bearing value of the soil existing in some localities, it is often necessary to spread the footings of the foundation over a larger ground area in order to support the concentrated weight and also to prevent settling from this cause. The supporting value of soils per square foot varies in its character, but in general the supporting power in tons per square foot, according to "Baker Treatise in Masonry Construction," may be taken as follows:

	Supporting Value in Tons per Sq.Ft.	
	Max.	Min.
Rock—Granite, etc., in hard compact strata	200	
Rock—Limestone equal to best masonry	25	30
Rock—Sandstone, equal to best brick masonry	15	20
Rock—Broken and well compacted	7	20
Rock—Soft and pliable as shale, equal to poor masonry	5	10
Hardpan—Gravel and sand, well cemented with clay	8	10
Clay—Thick beds and dry	4	6
Clay—Thick beds and moderately dry	2	4
Clay—Soft, wet, confined	1	2
Gravel—Coarse and dry, well compacted and confined	8	10
Sand—Dry, compact, well cemented with clay	4	6
Sand—Clear and dry, confined in natural beds	2	4
Quicksand—Marshy and alluvial soils, etc., confined	0.5	1

As an example, suppose it is desired to determine what the spread of a foundation should be, assuming

the weight of the engine as 24 tons, the soil being clay, thick beds and moderately dry. It is found from the table that this quality of soil has a bearing value of from 2 to 4 tons per square foot. To be safe, it is best to use the lowest of these figures, which is 2 tons. We then have:

$$\textit{Sq.ft. of bearing surface} = \frac{\textit{Weight in tons to be supported}}{\textit{Bearing value of soil}} = \frac{24}{2} = 12 \textit{ sq.ft. of bearing surface required.}$$

The bottom of the foundation will therefore have to spread over an area of at least 12 sq.ft. to support this load.

In making the forms, spruce seems to be the best all-round material and the siding should be of either

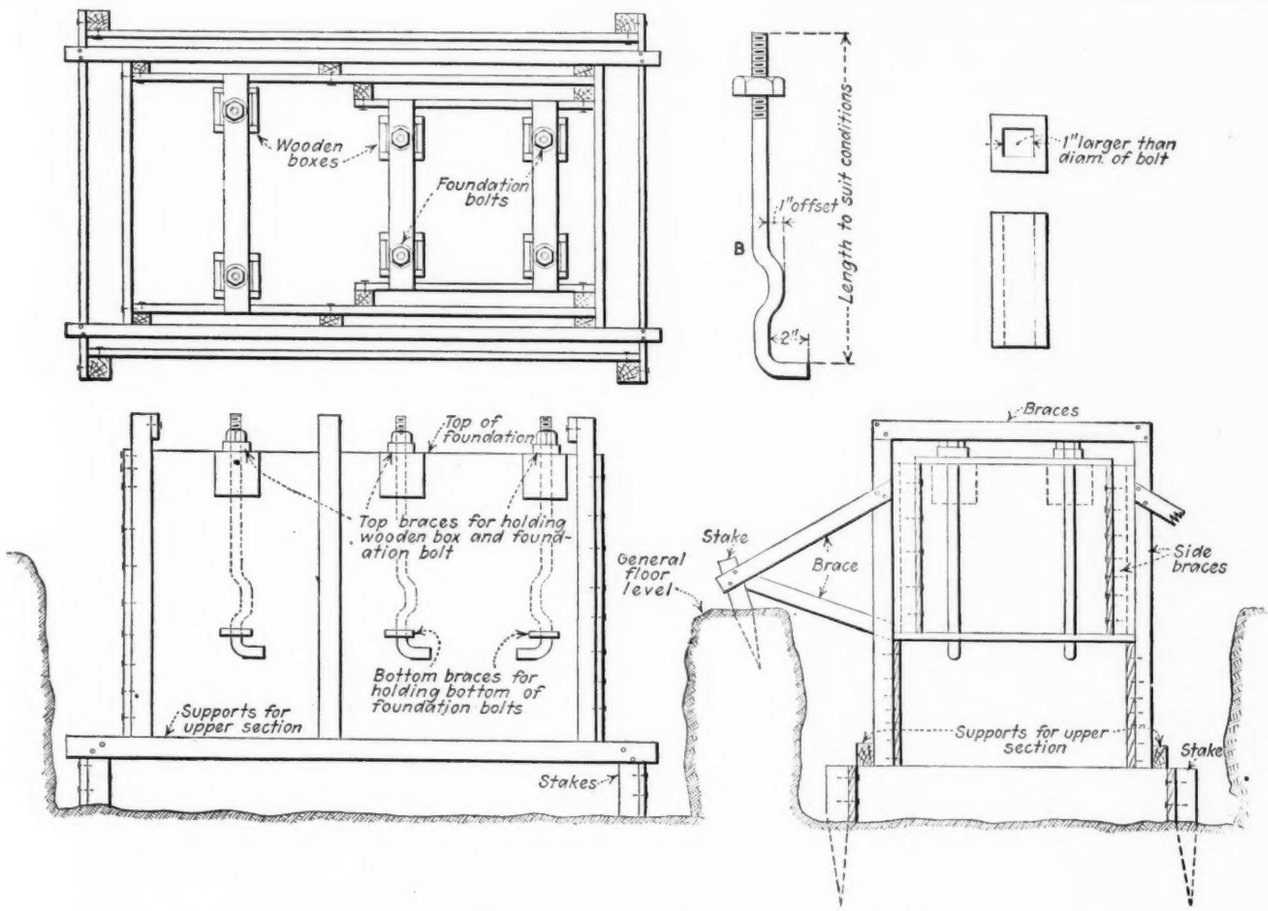


FIG. 2. PLAN, ELEVATION AND SECTION OF FOUNDATION

⅞- or 1-in. material, dressed on one side. It has been the writer's practice to make the foundation about 1½ to 2 in. larger than the bedplate of the machine all around, thus providing sufficient room around the bedplate for pouring the grout, at the same time giving the foundation a better appearance.

After the form is completed, it is placed in position, lined up and leveled, also thoroughly braced to prevent it from shifting while the finishing touches are being made or during the pouring process.

In making the foundation bolts, take care that the thread is cut to the proper length, as called for on the manufacturer's drawing previously referred to. It has been the writer's practice to make the bolts for small foundations as shown by detail *B*, Fig. 2. Although there are several other methods of making foundation bolts, this type is easily made, and the slight offset prevents it from turning after the concrete is thoroughly set.

It is also necessary to make some provision for play in the upper part of the bolts for slight adjustments, due to slight variations in the casting. This is frequently done by means of short pieces of pipe set around the foundation bolts to act as a sleeve. The diameter of this sleeve should be sufficiently large to allow at least 1-in. space around the bolt. Although this type of sleeve is often used, there is an objection to it on account of the difficulty in supporting it properly in the forms. It frequently happens that the sleeves are distributed during the pouring and tamping process, thereby rendering them useless in providing proper clearance around the bolts.

It is good practice to use square wooden boxes for this purpose, made about 1½ in. larger internally than the diameter of the bolts and about 9 in. long. For details see Fig. 2.

The center line of the form for the foundation is now determined and marked by means of a cord stretched from one end to the other, and the proper location of the bolts determined from this line, and the bolts and boxes supported as shown in Fig. 1. The nuts are also put on and turned down until the bolts extend above the top of the foundation the distance called for on the manufacturer's blueprint, making due allowance for grout. The form work is now ready for the concrete.

A good concrete is made by mixing one part of Portland cement, three parts of sand and five parts of broken stone or gravel small enough to pass through a 2-in. ring. This should be mixed very wet. Another proportion sometimes used for engine foundations is one part of Portland cement, two parts of sand and four parts of broken stone, which is known as 1:2:4 mixture. It must be remembered, however, that where a

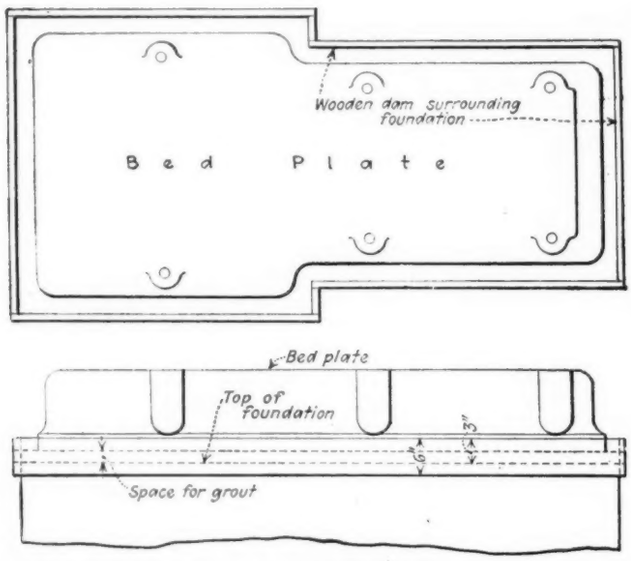


FIG. 3. PLAN AND ELEVATION OF FOUNDATION WITH WOODEN GROUT DAM IN PLACE

concrete floor is utilized for the base of the foundation and before any concrete is poured, that portion of the floor must be thoroughly soaked with water, after which a grout mixture of cement is thoroughly scrubbed into the old concrete, using clean brushes, and before this is set the proper concrete mixture poured into the form, taking care not to fill the boxes surrounding the bolts. The concrete, while being poured, should also be well tamped to avoid leaving unsightly surface pockets, so that when the form is removed a dense smooth surface will exist.

The forms may be removed in about four days, at the same time knocking out the wooden boxes surrounding the foundation bolts. The foundation is usually allowed to set for a week or ten days before any heavy weight is placed on it. It is also a good plan at this stage to compare the location of the bolts with the base of the machine, and if there should be a little variation, the space surrounding the bolt will allow the upper part of the bolt to be sprung enough to match the holes in the bedplate.

After the bedplate is placed on the foundation, it is lined up and leveled by means of wedges and shims, at the same time allowing sufficient space between the foundation and engine base for grout. This is usually one inch. The nuts may now be put on the bolts and turned down hand-tight.

Next a wooden dam is built around the foundation, as shown in Fig. 3, and the grout poured in around the edge of the bedplate, using a mixture of one part of cement and one part of sand. This should be sufficiently soft to allow it to flow freely under all four sides of the bedplate. It is allowed to set for three or four days, after which the dam is removed and the nuts tightened to full bearing, taking care that the alignment and level of the bedplate are not changed. If there should be any slight imperfections in the surface of the foundation, they can be touched up with a mason's trowel.

Bailey Multi-Pointer Draft Gage

Accurate draft readings are of importance in operating the boiler and stoker. With forced draft it is desirable to maintain the furnace draft with an accuracy of 0.01 in. of water. The divided windbox used in some types of underfeed stokers and all types of forced-draft chain-grate stokers requires individual draft readings. Draft readings from other points in the gas passages are useful when they can be readily and accurately compared with draft pressures at other desired points.

To meet this need, the Bailey Meter Co., Cleveland, Ohio, has developed the multi-pointer gage shown in the illustration. Each pointer has a 10-in. motion along the arc of an illuminated scale. The gage can be made in sizes to accommodate from two to twelve pointers.

The draft is connected to the standpipe in the oil-seal bell, which is balanced by a counter rod at the opposite end of the beam. Both the bell and counterweight and beam are suspended from knife-edges to reduce friction.

The draft suction lifts the oil within the bell and draws the bell deeper into the oil. This force is balanced by a pendulum plate that is between the bell and

MECHANISM OF THREE-POINTER GAGE

counterweight and is moved horizontally and thereby introduces a moment of force that balances the force due to the draft suction on the bell.

The range in draft pressure or suction may vary from a maximum of 0 to 7 in. of water to a minimum of 0 to 0.10 in. for the full pointer motion of 10 in. The usual range for firebox draft is +0.10 to —0.50 in. of water. All positive readings increase with upward pointer motion, while increasing negative readings or suction are indicated by a downward motion. Each scale reads directly and is labeled to show with what it is connected.

EDITORIALS

Armature-Winding Diagrams

TO THE average operating engineer and practical electrician an armature-winding diagram is a complicated lot of connections. However, if a little study is given to these diagrams, they will be found to be based on a few simple fundamental principles, and if these are understood the system of laying out the diagrams becomes comparatively easy.

In general most diagrams are laid out with single lines representing the coils, which no doubt tends to make these windings look formidable. In the series of articles on "Locating Faults in Direct-Current Armatures," the third of which appears in this issue, B. A. Briggs has introduced a scheme of laying out windings that gives a clear picture of how the coils are arranged on an actual machine. Instead of the conventional single-line representations of coils, they are drawn out complete and assembled as on an armature. Therefore, in making a study of the effects of troubles in winding, Mr. Briggs' diagrams show up clearly what actually happens. The fact that the armature is the vital part of any electrical machine and the part in which probably ninety per cent of the trouble experienced with the machine occurs, makes this part of particular interest to operating and maintenance men.

It is easy to say that the trouble that may occur in an armature is generally confined to open circuits, short-circuits and grounds, but an entirely different matter to be familiar with the various conditions under which these faults may occur. Having a clear picture of the winding makes easy a clear conception of what the effects of the faults are under different circumstances.

Why All the Waste?

IF THERE is one sin more than any other that the civilized world has attached to itself, it is wasteful methods. Practices that waste time and human energy almost without number we have taken unto ourselves. We are wasteful of our natural resources to a staggering degree. We dig coal from the bowels of the earth by the millions of tons, haul it long distances by burning coal, and then burn it for power purposes that could just as well be supplied by water, the only self-perpetuating source of power we have. Furthermore, anywhere from ninety to eighty per cent of the energy in the coal is thrown away to obtain the other ten to twenty per cent—more frequently ten per cent than twenty. A survey of three thousand central stations in this country showed an average coal consumption of three pounds per kilowatt-hour. If the average heat value of the coal is taken at thirteen thousand British thermal units, this will give an average thermal efficiency of less than nine per cent. In other words, more than ninety-one per cent of the coal burned was wasted to obtain less than nine per cent. These figures may not be quite so bad as they look, since the survey figures are based on an average of the coal consumption by each plant and not on a ratio of total coal burned to total kilowatts delivered to the feeders. Be this as it may, the average in any case is low.

This, however, is only half the story. After being delivered to the busbars of the plant, this power must be distributed, and frequently in passing through the various transforming and transmitting equipment twenty to twenty-five per cent of this energy is lost before reaching the place where it is utilized. Some engineers have placed these losses as high as thirty per cent for good design and forty-five per cent for poor design.

In utilizing what is left, other wasteful methods are frequently practiced. A large motor is used to drive a group of intermittent-duty machines which, if driven by individual motors, would run a small percentage of the time only, with a power consumption in proportion. Not infrequently, where the distribution feeders are of considerable length they are too small for the load, resulting in a considerable power loss besides a reduction of the motors' speed, causing a loss in production the cost of which may make the few dollars saved in feeder copper fade into oblivion. There are almost as many sources of power waste and losses of production as there are motor applications.

However, the waste does not end here—the lighting system is another serious offender. A large percentage of the light actually produced may be lost in improper lighting units and fixtures. Even where the lighting equipment is good, failure to keep it clean results in a seriously impaired illumination and loss of production.

It is well-known that water power cannot supply all our power needs—in some parts of the country only a very small part of the total requirements—but for utilizing these resources there are large opportunities that have not been taken proper advantage of. In steam-power plants an over-all thermal efficiency of about twenty per cent is the best obtainable when the very best known practice is adopted. Although this is bad, it is far superior to the average, so much so that no further evidence is necessary to convict us of our wastefulness.

The Engineer with the Shovel

IN THE last few years, and indeed, even in the last few months, leaders of thought in engineering circles have been making a concerted effort to sell the engineering profession to the general public and to create in the public mind a true conception of the real ability and intellectual attainments of engineers as a whole, these qualities too often remaining hidden behind a modesty of nature that appears to be peculiar to the profession. As a means to the same end, efforts have also been mad to increase the self-esteem of engineers, to encourage them to enter into public discussions with greater assurance and to step into their proper places in the public eye, beside the lawyer, the doctor and the banker.

On account of its significance to this movement, a

statue that has recently come to public notice is called to the attention of *Power's* readers by means of a photograph on another page. It will be noted that this statue is of a manual laborer, a perspiring toiler with back bent under the strain of wielding a heavy shovel, and yet its title is "The Engineer." Compare this idea of the engineer with that of Thomas Tredgold, whose classic definition of engineering, modernized by Henry Gordon Stott, is "The art of organizing and directing men and of controlling the forces and materials of nature for the benefit of the human race." Why, when molding a statue whose name shows the intention of making it symbolical of the engineering profession, should the lowest level of achievement be seized upon as representative of the profession?

This is not the first time that this ludicrous conception of the engineer as a grimy laborer has been made evident. Some of those whose memory harks back to the early days of the American Society of Mechanical Engineers will recall the time when the organization ventured upon a dinner, dance and reception at Delmonico's. The society was young then, and up to that time its various functions had been held under quite modest circumstances, but Secretary Hutton had induced a society lady of New York to grace this grander occasion with her presence. In making her adieux, the lady expressed her appreciation to Secretary Hutton for a very pleasant evening, and remarked that she had been surprised "To find the engineers so well dressed and intelligent a body of men."

Many engineers will find it difficult to understand how such public misconceptions can obtain; nevertheless they exist, even today, and perhaps it is just as well that this statue of "The Engineer" has been made —possibly it will jog engineers into a knowledge of what a considerable part of the public thinks of them. In that case the work may have an effect upon engineers that will offset to a certain extent its unfortunate and grotesque impression upon the general public.

Prosperity as the Cause of Unemployment

A NEW thought upon the old subject of business cycles was brought out at the Washington conference on unemployment. It is a natural human tendency to attack a problem directly, rather than to seek for an obscure cause, and so many will feel surprise at the proposition advanced at the conference that business depression and consequent unemployment have their origin in boom times and follow them inevitably. The thought here is that in times of prosperity there is speculation, over-expansion, extravagant living, relaxation of effort and wasteful expenditure in industry and commerce, all of which destroys capital and causes the pendulum to swing to the other extreme of business depression and acute unemployment. In other words, it is the old story of the fall of Rome, occurring over and over again in apparently endless repetition.

From this it follows that the time to prevent acute depression is at the height of the boom. So by holding in moderation the forces and tendencies that now run riot when business is good and money is plentiful, the inevitable swing back to the opposite condition will be less violent and far-reaching.

Perhaps such a thought is the key to the solution of some of the greatest difficulties of the time, and it may be that national leaders of thought will be able to devise a program upon such a foundation that will prevent the intolerable waste and suffering of recurring periods of business stagnation.

We have all been taught by our fathers and mothers and by our teachers in school the principles of foresightedness and thrift; that when the sun shines we should make provision for the rainy days ahead, that in our youth we should lay aside a nest egg for our old age, and that when times are prosperous we should accumulate a bank account for use when we may possibly find ourselves out of work. These principles have never been questioned in their application to individuals, but in connection with the vastly more important problems of national existence they do not seem to have been given consideration.

Pumping Coal Through Pipe Lines

FOR many years materials such as sand, gravel and crushed rock have been handled by centrifugal pumps and pipe lines. This success prompted many to turn their attention to the problem of pumping coal from the coal fields to tidewater by similar means.

Lately, this problem has received considerable attention from engineers and the owners of public utilities. On another page appear extracts from a paper on the subject delivered before the meeting of the Edison Illuminating Society. The data given would seem to prove that the cost per ton is much under present coal rates. There are, on the other hand, problems of engineering and operation which make the solution by no means simple. The question of erosion of the pipe line, as well as lowering of the grades of coal resulting from rubbing and breaking, is still unanswered. The paper did not bring out the amount of water required per ton of coal, but in view of the experience in handling gravel, the ratio of water to coal will undoubtedly exceed three to one, which involves the securing of a large water supply which, to avoid serious corrosion of the pipe line, should be comparatively free from acids.

A satisfactorily operating synchronous motor is generally considered as a comparatively recent production of the electrical art. This to a large degree is probably true; however, there are large synchronous motors of the early vintage that have over twenty-five years of service to their credit. It must be that some of the predecessors of the modern machine did not act so badly as we have been led to believe. The more this type of machine is studied the more it becomes apparent that too much attention has been centered on its few undesirable features to discourage its use, and not enough on its many desirable characteristics to encourage its wider application.

Indications are that Senator Kenyon of Iowa is going to make a stiff fight for his coal stabilization and coal profiteering bills, which he recently introduced in the Senate. He has stated that the Frelinghuysen Stabilization Bill would not accomplish the desired object, and although he has admitted that it is difficult to stir up sentiment for legislation of this kind in Congress at this time, he feels that the people will eventually awaken and demand some such legislation as he proposes.

PRACTICAL IDEAS from PRACTICAL MEN

Used Exhaust Steam in Burning Buckwheat Coal

When the high prices came on during the late war period, efforts were made to burn the lower grades of coal, such as buckwheat, and then trouble began, as nothing finer than No. 2 buckwheat could be burned and the clinkers that formed were difficult to break up.

Finally, exhaust steam from the fan engine was turned into the forced-draft air duct, which improved conditions somewhat. This was encouraging, and so a steam-jet blower was installed which permitted using Nos. 3 and 4 buckwheat, with no clinkers to speak of. The steam jets consumed about 2 per cent of the boiler output.

From our experience it was decided that although the exhaust steam in the ashpit softened the clinker and made it easier to handle, there was not enough steam to prevent clinker from forming. Perhaps other engineers have had more promising experiences in using exhaust steam for burning buckwheat coals. C. W. HARRIS.

New York City.

Why Speed of Motor Could Not Be Adjusted

After wiring up a 7½-hp. variable-speed three-phase alternating-current wound-rotor motor, considerable difficulty was experienced in locating what was wrong with the motor, in that it would only operate at two speeds, when the controller and resistance grids were designed to give five different speeds. On starting up the motor, everything seemed in good order and working properly, until the revolutions were checked, which showed only two speeds. On the first point of the controller the motor ran at one-half full-load speed and did not change its speed until the controller handle was turned about three-fourths of the way around, when it picked up to full speed, and then did not change any as the controller was advanced the rest of the way around, to the full-speed position.

As this was a new machine direct from the factory, it was taken for granted that the motor was in good order, therefore it was not inspected. It was suspected that there was something wrong with the wiring of the controller and resistance grids. The wiring was carefully checked and did not show any wrong connections. This indicated that there might be something wrong with the motor. First, the brush rigging was looked over and did not show anything wrong. Then the leads from the slip rings to the controller were disconnected and current applied to the stator. This resulted in the motor turning over slowly, which showed that there was a short-circuit in the rotor. The end bell was then removed and the rotor winding tested and found in good order. With the end bell removed, the trouble was located. It was found that the bolts which held the pigtails onto the brushes were too long and touched between two of the slip rings, thus short-circuiting the resistance out of two phases. MARIN PHILLIPS.

South Kaukauna, Wis.

Gearing for Increased Engine Speed

The governor and valve gear on one of the engines in our plant is driven by means of a gear shaft, the crank and valve side shaft making one revolution simultaneously. It was desired to change the speed of the engine 27 revolutions per minute, and this necessitated changing the gear driving the governor. Perhaps the way this was done will be of interest to some reader.

The governor gearwheel had 42 teeth and the side-shaft gearwheel had 49 teeth. The engine formerly ran at 73 r.p.m. and 100 was wanted. Originally, the governor shaft made $49 \div 42 = 1\frac{1}{6}$ revolutions to one of the governor and the governor ran $73 \times 1\frac{1}{6} = 85\frac{1}{6}$ revolutions. It is evident that the governor had to be kept at about this speed for the new engine speed.

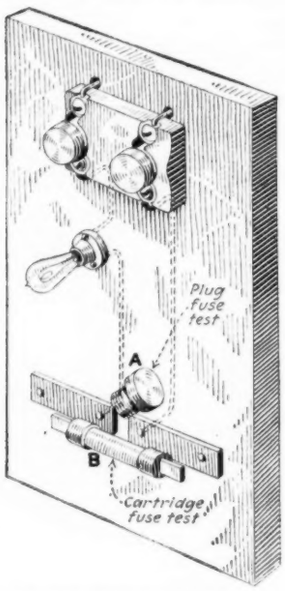
With the engine running at 100 revolutions and the governor kept at 85, the governor would have to run 0.85 as fast as the side shaft. Therefore the gear on the side shaft must have 0.85 as many teeth as that on the governor shaft. As the gear on the governor had 42 teeth, the number of teeth on the side shaft would be $42 \times 0.85 = 35.7$, or 36 teeth, in which case, with the governor running at 85 r.p.m., the engine would run $\frac{42}{36} \times 85 = 99\frac{1}{6}$ or 99 revolutions, which was near enough.

It is seen that knowing the governor speed any gears convenient could have been used so long as the one on the side shaft had 0.85 as many teeth as that on the governor. W. E. SMALL.

Boston, Mass.

Pointers on Electric Fuses

When an electric fuse is blown by an overload, many operators consider it of no further value, hence they throw it away and insert another. This refers to the so-called "non-refillable type," in which no provision is made for repairs by the operator after it has once failed. However, this is a mistaken idea, since these fuses may be sent to the manufacturers, who will refill them for a fraction of the original cost, making them as good as new. Therefore blown fuses should not be thrown away, as they are valuable, particularly those of 75-ampere capacity and above. Of course it costs something to send them and pay the return charges, but the parcel post system has made it possible, also practical, to do many things that formerly were not worth while. In order to try this scheme, it is only necessary to save half a dozen of these fuses, have them refilled and compare the cost with the price of a new set.



FUSE-TESTING BOARD

There is always a temptation to replace a blown fuse with a piece of wire when another is not at hand. A wire thus used is always a dangerous practice, unless one side of the system is permanently grounded. The following precaution should always be taken in such a case. Remove the blown fuse and put the good one in its place, then put the doctored fuse on the other side. The use of a wire instead of a fuse thus changes the line from a double-pole to a single-pole fused circuit, and allows the line to be used until another fuse can be procured. I do not favor this practice, but am pointing out the possibilities.

Nearly all non-refillable fuses are fitted with some kind of a device for telling when they are blown. Some of these are reliable while others are not. When a fuse is supposed to be blown in my plant, the operator brings it to the engine room and exchanges it for a good one. It is a good plan to test all such suspected specimens, and for this purpose a simple home-made device answers every purpose. It consists of a circuit including one lamp, which connects to two copper strips, as shown in the figure. These strips are set close enough at the ends so that a plug fuse can make contact from one to the other, as indicated at *A*. Cartridge-type fuses are tested by laying one terminal on each bar as shown at *B*. If a good fuse is held so as to form a part of the circuit, the lamp is lighted, but if the fuse is blown, it will remain dark. Many of the fuses turned in as blown are found to be good. This is sometimes due to the fact that the operator cannot tell which one of a pair of fuses has failed, and he replaces both.

A prolific cause of fuses blowing is failure of the no-voltage release coil on motor-starting boxes to release the lever and allow it to return to the starting position. The operator does not notice that the lever has stayed in the running position, but when the machine is started again, he throws in the switch and applies full voltage to the stationary motor, which results in one or both of the fuses being blown. It would appear that one such lesson should be enough, but such is not always the case. It must be repeated several times before the operator learns to be sure that the lever has returned to starting position.

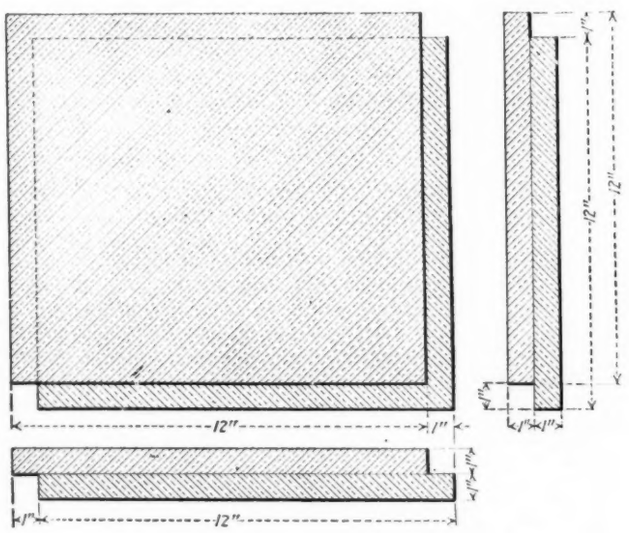
If a fuse heats in service, it is an indication of overload or else the ends are not in perfect contact with the holding clips. If conditions were satisfactory when the fuses were first put into service, this is no proof that they are still correct, as corrosion may have acted to put a thin film of non-conducting material between the metal surfaces. All parts coming into contact should be thoroughly cleaned with emery cloth and care taken to have the clips formed into proper shape to actually touch every part of the fuse that ought to be in contact. Even where a fuse is held in place by a screw or a bolt, the contact is not always perfect. Heating of fuse terminals, due to poor contact, has been the cause of more of these devices blowing than is generally appreciated.

New Haven, Conn. H. W. WAKEMAN.

Special Lap Tile for Boiler Baffles

The Springfield (Ohio) Light, Heat and Power Co. has experienced some little difficulty in its boiler plant with leakage through baffles made of ordinary 12 x 12 x 2-in. baffle tile. We are now trying out a special lap tile made in accordance with the accompanying sketch and our experience so far has been satisfactory in every respect.

This tile is used particularly with Stirling and Connelly boilers, but it can be used on any boiler that requires this type of tile. Certain baffles in our Badenhausen boilers can be made of it. The tile can be made by any refractories manufacturer at a very slight increase in cost over the standard 12 x 12 x 2-in. tile. Baffles made from it are tighter to begin with than the standard make, and the joints remain tight indefinitely or at least as far as our experience indicates. The tile is laid in exactly the same way as the standard tile except that the joints are buttered with a high-temperature cement or fireclay.

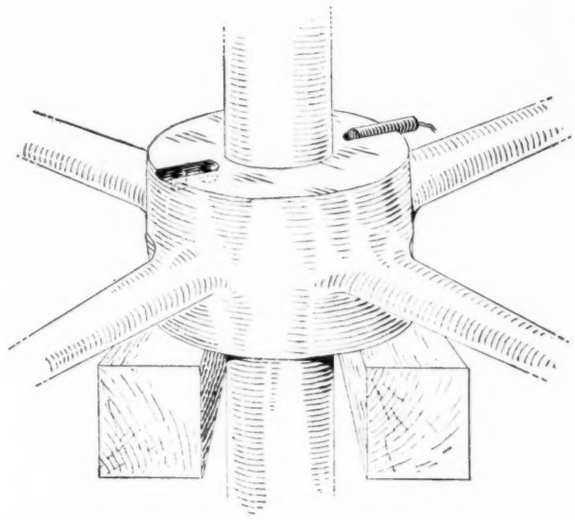


LAPPED TILE FOR BOILER BAFFLES

L. E. BROWN,
Springfield, Ohio. Production Manager.

Removing Tight Sheave-Wheel Shafts

At a certain shaft coal mine it became necessary immediately to replace the old sheave wheels with new ones. The new sheaves, which were duplicates of the old ones, had no shafts and all attempts to remove the old shafts were fruitless. As this was an emergency



DYNAMITE WAS PLACED IN EACH NOTCH

job requiring prompt replacement of the sheaves, but one method was left—dynamite.

The sketch shows how this method was employed. On each side of the shaft two 1-in. holes were drilled 2 in. deep in the end of the hub and a notch cut in the metal over the holes. Then one-half stick of dynamite was placed on each notch and both charges were fired simultaneously. The hubs were cracked and the shafts, uninjured, were easily removed. J. L. BALL.

Amsterdam, Ohio.

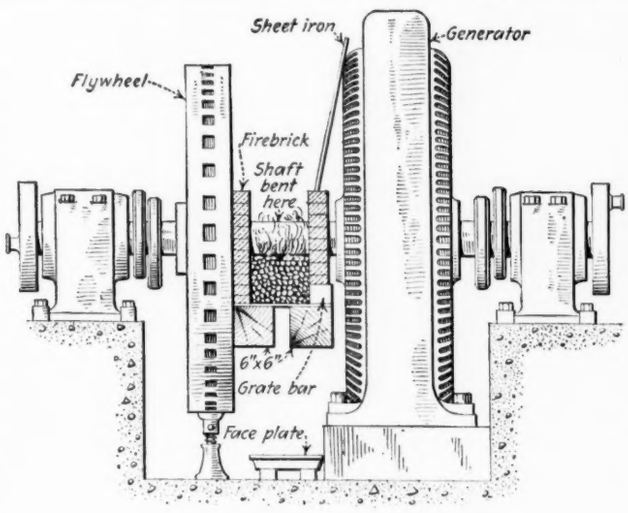
Straightening a Bent Crankshaft

During the fall of 1916, when the demand for coal was much greater than the supply a large colliery where I was employed had a generating set wrecked, which was badly needed. The worst among the many things that happened was the bending of the crankshaft between the rotor and the flywheel. The set was a horizontal cross-compound, running 150 r.p.m. and had a crankshaft 13 ft. 6 in. long, and with the flywheel and rotor weighed about thirteen tons. The flywheel and rotor hubs were but 15 in. apart, the shaft at this point being 10 in. in diameter, and it was here that the bend occurred. The shaft, when rotated, ran roughly $\frac{7}{16}$ in. out of true. A new crosshead and some welding fixed the rest of the damage, but the crankshaft presented a serious problem. We asked for advice but nobody seemed to have any suggestions except to order a new shaft. We might have waited six months for this, so I decided to go after the job myself and try to straighten it in position. The first thing was to ascertain the exact position and extent of the bend. This was done by placing a faceplate on the foundation under the shaft, and from this two bar gages were made, one with the bend up and the other with it down. The difference was then determined and a heavy bar gage of $1\frac{1}{2}$-in. cold-rolled steel made that would exactly fit under the shaft when straight. The shaft was then turned with the bend up and a jack placed under the flywheel just taking the weight.

To get the shaft red-hot was the next operation, and this proved no easy matter. There being no coke for hundreds of miles, it was decided to use the coal from our own mine, which was a high-grade bituminous. The work was started with an ordinary grate bar about 18 in. down from the shaft, and we built a firebrick furnace up around it, using compressed air for a blast. When the fire was getting along fine, the grate bar began to clog up and shut off the air, so we had to try again.

The next time the grate bar was turned on its side and built in on the side of the furnace so that the ashes could fall down past it. This worked very well, but after the shaft was hot, it took so long to remove the furnace that the shaft cooled off, and when the jack under the flywheel was released, the shaft refused to go down.

We then started out with two 6 x 6-in. timbers about 12 ft. long placed at right angles to the shaft. An iron plate rested on them, and upon it we built the furnace as before, and this time, when the shaft was hot, the plate, fire, firebricks and the 6 x 6-in. timbers were dragged away. Then placing the heavy bar on the faceplate under the shaft, we eased off the jack under the flywheel and allowed the weight of the rotor and flywheel to bring the shaft down onto the gage. When the shaft cooled, it lifted 0.002 in. from the gage, and this



HOW THE SHAFT WAS HEATED

represents all the error now in the shaft. The flywheel and rotor bolts were all loosened, and the field coils were protected by sheet iron from the heat. The job took a week and was done before the new crosshead was received.

Of course care must be taken in building the brick partition next to the generator so as to be sure that the windings will not be injured, and care must also be exercised in adjusting the jack under the flywheel after heating the shaft; otherwise it may be sprung opposite to what it was in the first place.

Since starting up the machine has been in operation practically every day and has never given any trouble whatever, being apparently no worse for the accident. The sketch illustrates the methods used in doing the job.

Macleod, Alberta, Canada. VERNON PEARSON.

Fractions and Decimals*

There is a difference between decimals and fractions, as everybody should know; 0.005 in. means $\frac{5}{1{,}000}$ in., and 0.0005 in. means $\frac{5}{10{,}000}$ in., or one-half of one one-thousandth, a term that is much used nowadays. Yet there seems to be a tendency to confuse the simplicity of decimals and make a deplorable combination of the two, like this—0.000½ in.

What does 0.000½ in. represent? A half of a thousandth or a half of a ten-thousandth? I don't know.

Although those who write such expressions claim that it means a half a thousandth, I maintain that it means nothing. There is no such "animal." There is no excuse for "balling up" our mathematics in such a way as that, and the habit should be stopped before too many catch it.

If a half of one-thousandth inch is to be written, it should be written in this way: 0.0005 in., $\frac{1}{2{,}000}$ in. or $\frac{1}{2} \times \frac{1}{1{,}000}$ in. or $\frac{0.5}{1{,}000}$ in. All these are in perfect accord with mathematical practice, and there is no question as to their meaning. Why use a questionable method?

Newark, N. J. W. F. SCHAPHORST.

Treatment of Electrical Burns

Almost every set of recommendations as to first aid for electrical injury gives instructions for resuscitation, as is quite proper; and the method of resuscitation has been changed to meet the dictates of experience. However, very few recommendations are made with regard to the treatment of burns, which may be quite deep and over large area. In cases where prostration does not result at the time, frequently sufficient warning is not given with regard to treatment of shock.

I have in mind a number of cases where men have received flash burns that covered a rather large area and that were so painful that the proper treatment in the first place meant a great deal, and where shock was not suggested to those who took care of the injured men simply because the latter were not prostrated at the time and even seemed rather active, but afterwards succumbed to the shock. In one recent case a man died when he was thought to be all right, not having been prostrated at all.

Picric acid is seldom mentioned, and yet I believe that this acid and prepared dry picric gauze are far better than carron oil for the treatment of burns. Believing, as I do, that these two things should receive more consideration, I am bringing this to the attention of *Power* readers with the hope that the subjects will be investigated and the best-known methods given some publicity.

J. M. BUSWELL, General Inspector,
Fresno, Cal. San Joaquin Light and Power Corp.

Washing Out Vertical Water-Tube Boilers

We read considerable about the care of horizontal return-tubular and water-tube boilers, but it is seldom that anything is said about the care of vertical boilers, either fire- or water-tube. Perhaps the way we handle our vertical water-tube boilers for washing out may interest someone.

After the fire is dead and the boiler brickwork is cooled, about an hour later, the boiler to be cleaned is cut off from the header and the valve in a ¾-in. pipe leading from the steam drum is opened to provide a gradual escape of the steam into a common pipe that is connected to the bleeder pipes of the other boilers.

The fire and the ashpit doors are kept closed for about six hours after drawing the fire, then they are opened and the chimney draft is allowed to cool the interior of the furnace and boiler setting.

After the boiler has been dead about twelve hours, the water is drained out, the manhole heads are removed and the interior of the boiler is washed out by means of a strong stream of cold water, which washes loose scale and sediment that may be in the tubes, into the mud drum. In our plant the tubes are turbined about once in six months, as there is not much scale accumulation.

When getting up steam, the ¾-in. bleeder pipe can be used to equalize the pressure in the newly-fired boiler with that in the others, as the working pressure approaches.

W. R. RAYMOND.
Utica, N. Y.

Plastered the Hub-Flange Bolts

Some years ago a heavy pumping engine was being installed having a large flywheel the arms of which were bolted between the flanges of the hub. The bolt heads and nuts, of course, projected beyond the surfaces of the flanges. This led the operator to speak of the difficulty of keeping such a surface clean, for as the engine had to be in constant operation, some parts had to be wiped off while the machine was in motion, and obviously the bolt heads and nuts would be a hindrance.

It was suggested that wall plaster might be applied to fill the spaces between and over the bolt heads and nuts, finished with a hard coat, which, when painted, would not be distinguishable from the rest of the wheel, and the idea was approved.

As the vertical boilers were then being covered, it was decided to use the boiler-covering material for the wheel, and a contract was made with the boiler-covering man to do the job. He stated that he would do the best he could, but could not guarantee that the surface would run true. He was provided with a wooden sweep, arranged to be guided by the wheel shaft and cut to the contour expected for the finished job, which was thought would be true enough; he was to make the hard coat thick enough so that, if unsatisfactory, it could be trued up with a turning tool without cutting through it.

The material dried out almost as hard as iron, but when the engine was started, it was found that a little turning would give it a better appearance when in motion. So a board for a tool rest was rigged up and the end of an old file was ground to a cutting edge, and after covering up the bearings to keep out the dust and running the engine slowly, in a short time the job was made as true as need be, but it was a dusty job.

Philadelphia, Pa. ALONZO G. COLLINS.

As a part of its "Good-Will" promotion work, the National Electric Light Association has had prepared a one-reel moving picture film entitled "Back of the Button," which was shown for the first time at the Chicago Convention in May. It is understood that the Association plans to produce more such films as a means of increasing public confidence and interest in the electric-power industry.

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CORRESPONDENCE

Lengthening and Shortening Corliss Governor-Valve Rods

Regarding P. A. Upham's letter on changing governor reach rods of a Corliss engine, page 574 of the Oct. 11 issue of *Power*, lengthening the long rod and shortening the short one would pull the trip cams farther back and, with the same position of the governor, give a longer cutoff. But if the steam pressure and load are the factors that remain constant, the engine would speed up the very small fraction of a revolution needed to raise the governor a little farther and bring the trip cams back to the place where they were before changing the governor reach rods, so that the cutoff would be practically the same as at first.

It is likely that if the engine were driving the usual mill load and sufficiently accurate instruments were used the amount of speeding up and the slightly later cutoff due to the greater resistance of the machinery to driving at higher speed could be measured, but both would be small and practically could be neglected.

If the engine were pulling against a constant resistance, such as raising a weight, the increased horsepower would be accounted for altogether by the increased speed and the cutoff would be exactly the same. In other words, if the torque required from the engine did not change with a slight increase in speed, the cutoff would remain the same but if, as is usually the case, the torque increased with the speed, the cutoff would lengthen until the new mean effective pressure was increased in the same proportion. H. D. FISHER.

New Haven, Conn.

Using a File on Bearings

I would not advise engineers who have read the several discussions in *Power* as to the high advantages secured by filing a shaft or babbitted bearing, to attempt to follow the suggestions offered. The more common-sense step to take is to find out why a bearing lacks oil and why filing tends to improve the lubrication. In all cases it is necessary that an oil film exist between the revolving shaft and the bearing. If this film fails, the bearing will heat up. It is at this point that the bastard file is offered as a remedy. Rather let the engineer inquire why the oil film no longer exists. Granted that the film originally existed, where did it go? With this knowledge the proper procedure is to correct existing conditions in order to bring things back to normal.

If a bearing has the proper oil ways cut into the lower babbitt shell and if the latter is properly chamfered at the parting edges, then there is no reason why the oil film should be dislodged as long as an oil stream is supplied to the bearing.

Unfortunately, in rebabbitted shells quite often no chamfer is cut on the babbitt and there is no tendency for the oil to be pulled into the space between the journal and babbitt lining. Frequently, the oil grooves are improperly placed, being too deep or cut with the ends too close to the edges of the babbitt.

The conclusion arrived at is that no hot bearing will occur if the oil grove is properly made and a stream of oil applied to the bearing.

If the journal is cut with a file, minute grooves will be formed. These grooves may pull the oil between the babbitt and shell. Picture, however, the destruction these same grooves will cause to the babbitt if the two touch or to the film if a film does form!

Undoubtedly, the proper way to oil an engine bearing is by force feed applied at a point on the lower half of the bearing where the bearing pressure is greatest. With this system no oil groove is necessary. In the absence of this system oil cups should be placed at least one foot above the bearing in order to give a head to the oil, insuring a flow. In addition, heavy oils should never be used.

My advice to engineers confronted with a hot bearing is to let the file stay in the tool box, clean the bearing and oil line and see that a supply of clean oil is furnished the bearing.

New York City. E. E. LONG.

Accident to Ammonia Compressor

In the October 4 issue of *Power* was described an accident to ammonia compressor, due to the breaking of the stem of the suction valve.

I had two similar accidents with the same general design of valve in a vertical three-stage air compressor. At the first accident the valve stem broke and dropped into the intermediate cylinder. The result was a damaged cylinder head, piston rod and two studs. The second time it happened in the high-pressure cylinder, resulting in a damaged cylinder-head, rod, cap and three studs. One man narrowly missed being hit by a pressure gage that was knocked clear off the compressor.

I consider this type of valve as absolutely dangerous, and anybody who has had to contend with breakage will agree with me. After the second accident I looked around and inquired about other designs of suction valves, but I could find nothing suitable.

So in my spare time I designed a valve, had it manufactured and tested out in the plant. The result was so satisfactory that I equipped both compressors with this valve. Two sets of valves were put in service Feb. 19, 1920, and are still in use 24 hours a day and every day in the year. They are in the best of mechanical condition and are taken out only once in a great while for inspection. The valve has a perfect seat all the time on account of large bearing surface. The stem cannot break and therefore an accident is impossible.

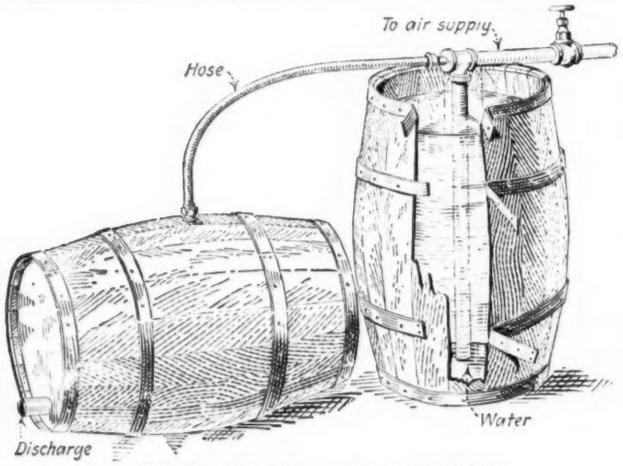
The valve does away with almost all the wiredrawing very common to other valves. It has a free, unobstructed air passage and is self-cleaning. I am well satisfied with its service and know that no accident like the one described will occur. PAUL ROTHE.

Chicago, Ill.

Emptying Barrels with Compressed Air

Regarding the discussion pertaining to emptying barrels with compressed air recently appearing in the columns of *Power*, there seems to be a difference of opinion as to the best method of doing this. The danger in applying compressed air in emptying a barrel is the excess pressure that may be built up in the barrel, which may be sufficient to explode it. This can be avoided in the following manner as illustrated: The oil barrel is on its side to be emptied and the barrel set on end is filled with water. In it a length of ¾-in. pipe is placed, extending to within one-half to one inch of the bottom. On the top end of the pipe is a tee connected to the source of compressed air at one outlet and to the oil barrel at the other.

It will be seen that this arrangement acts as a relief valve for the air, as in case the air pressure is suddenly admitted to the oil barrel or the pressure increases, the excess pressure will cause the air to go down through the pipe and bubble up through the water when it exceeds the pressure due to the weight of the



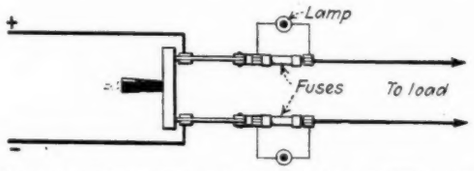
WATER BARREL FOR AIR RELIEF

column of water in the barrel. Every foot of water at 62 deg. F. has a head of 0.434 lb. per square inch, and the pressure that will be maintained in the oil barrel will be between 1½ and 2 lb., depending on the height of the barrel. In case a pound or two more pressure is desired, the same idea could be worked out by using a length of 5- or 6-in. pipe, putting the ¼- or ¾-in. pipe in it as described when used with the barrel.

Baltimore, Md. J. A. ANDERSON.

Locating Blown Fuses

In a location where fuses were often blown and there was no skilled help to test out for the failure, considerable annoyance was experienced in locating the blown fuse until the expedient was hit upon of permanently connecting a lamp in parallel with each fuse, as indicated in the figure. When connected in this manner, the lamp uses no energy when the circuit is



LAMPS CONNECTED IN PARALLEL WITH FUSES

normal, but when the fuse blows, the lamp is connected in series with the load on that line or branch, and thus gives a direct indication of the exact fuse or fuses blown. There is an additional advantage derived by the assurance of a light near the fuses at the time when it is usually most needed—when the fuse blows. The lamps last almost indefinitely, as they are called upon for comparatively short service.

Carmel, Ind. HENRY H. BRUNNER.

[The foregoing plan is effective only where the load remains connected to the line, such as a load of lamps, heating devices or chemical processes. Where a motor is the only load on the line, the controller would come to the off position, completely opening the motor circuit, and the lamp could not light, and fails to give any indication of the blown fuse. In this case, however, if the controller was moved to the first point, the motor would fail to start, but the lamp across the blown fuse would light.—Editor.]

Steam Consumption of Bleeder Turbines

For approximating the steam consumption of bleeder turbines, the following rule seems as accurate as the method given by Mr. Gershberg in his article appearing in the Oct. 11 issue of *Power*.

The total steam taken when bleeding will be approximately the sum of the steam taken at the given load running non-bleeding plus 60 per cent of the amount bled.

As valves cut in, obviously an abrupt rise occurs in any correct "Willans Law" line and a hump in the efficiency curve, which must be ignored in such ready approximation. Any bleeder turbine serves two loads, heating and electric, and really consists of two units on one shaft, one non-condensing and the other low-pressure, so that naturally one affects the other.

In the example given on page 557 I would not consider the assumed conditions proper for a bleeder turbine. In winter the non-condensing end must pass 22,000 lb. of steam and in summer only 9,600 lb., so that in the warm months it is decidedly underloaded. The low-pressure end must pass 9,600 lb. in summer and only 2,000 lb. in winter. Thus some part of the unit is at all times underloaded and presumably less efficient than when operating under normal conditions.

The comparison of a bleeder turbine, operated non-bleeding, with the same unit bleeding, does not seem

as good as comparison with a standard equal quality condensing unit and possibly also with a non-condensing machine. Obviously, the non-condensing end performance can be excelled by using a standard full-efficiency non-condensing turbine.

The point made about losing only 10 per cent of the heat available for heating when bleeding at 20 lb. pressure is well taken, but there are other important factors to consider, such as speed regulation on varying heat and electrical loads; the turbine capacity may be too great for the generator in summer and possibly too small in winter, or the condenser may be too large in winter if of the right size in summer.

There is a considerable field for the bleeder turbine, but unusual care is needed in its selection if misfits are to be avoided. J. B. WILSON.

Chicago, Ill.

What Is the Matter with the Steam Table?

In answer to the question of J. W. Douglass, page 537 of the Oct. 4 issue of *Power*, the density of water decreases as the temperature is increased above 39 deg. F., and the density of steam increases with increase of temperature and pressure. The two densities approach each other, and there is a temperature and pressure where the densities of each are the same. This temperatuure is 706 deg. F. and the pressure is 3,200 lb. per sq.in. At this temperature and pressure the properties of water and steam are the same.

It will be observed from the steam tables that after a temperature of 450 deg. is reached, an increase of temperature and pressure causes the density of the steam to increase more quickly. This accounts for the slow increase of total heat. After a temperature of 500 deg. F. and a pressure of 679 lb. per sq.in. are reached, the steam increases in density so fast as to begin to assume the properties of the water with which it is in contact, and the total heat decreases until, at a temperature of 706 deg. F. and a pressure of 3,200 lb. per sq.in., the total heat of the substance has become the heat of the liquid of the water; that is, the latent heat of evaporation has been reduced to zero when the total heat of the steam has been reduced until the properties of the steam and water are the same.

As 706 deg. F. is the absolute boiling point of water, an increase of temperature will cause the water or steam to assuume the properties of a gas. At any temperature above 706. deg. F. it is impossible to reduce the vapor gas to a liquid by compression. I. F. RICHMOND.

Claremont, N. H.

Exciter Failed to Generate

After a 35-kw. exciter had been overhauled, the machine was reassembled and started up, but would not generate. Several hours were spent testing, starting and stopping without avail, and it became evident that assistance was necessary. Then I was called in on the job. An examination was made of the terminals, looking for loose armature and field connections, but no trouble was found here. The series-field connections were then reversed and the machine immediately came up to voltage. This was evidently a case where, in replacing the armature and field connections when reassembling the machine, the workmen had reversed the series field, and this prevented the machine from coming up to the voltage. However, the man in charge still maintains that the series-field connections were not reversed and that the trouble was in a loose connection that he had overlooked. B. S. BAXTER.

Boston, Mass.

[It is difficult to understand how the series winding being connected in opposition to the shunt would prevent a generator from building up its voltage. The shunt-field current is so small that even if it were to flow through the series winding opposite to the shunt, its effect would be practically negligible. There are probably from 500 to 1,000 turns in the shunt winding for each turn in the series winding, therefore, with the same current flowing through both windings, which is the condition when the machine is coming up to voltage without load, the series winding can have but little effect one way or another. A more likely cause for the machine building up was the tightening of loose connections, or if the field connections were interchanged, they were the shunt and not the series. If the shunt field windings are connected in a wrong relation to the armatures, the machine cannot build up until the shunt leads are interchanged.—Editor.]

Protecting Handhole Bolts and Gaskets from Burning

On page 575 in the Oct. 11 issue of *Power* there is a statement regarding protecting handhole plates and gaskets with asbestos cement. I fail to see how asbestos cement, when applied to the "crowfoot," is going to protect the gasket. It will protect the rear-end crowfoot stud and nut, but there are some makes of handhole gaskets that do not stand up well even under the temperature of the water in the boiler.

Some engineers cut gaskets from sheet asbestos for use with a steam pressure of 110 lb. or less. I have used two sheets of ⅛-in. sheet asbestos for gaskets, smearing the side that goes on the boiler head with graphite to prevent the gasket sticking to the boiler head. Of course the gasket could not be used a second time.

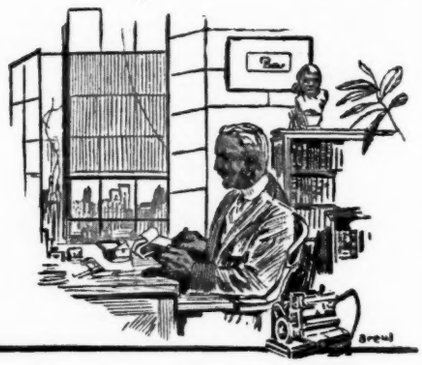
About twenty years ago braided asbestos handhole and manhole gaskets came into use, and by smearing graphite on the side next to the boiler the gasket stuck to the handhole or manhole plates and could be used over again many times. R. A. CULTRA.

Cambridge, Mass.

Napier's rule furnishes a simple and easily remembered method of figuring approximately how much steam at a given pressure will escape through a hole of any size. The rule is this: Steam flow in pounds per second equals the absolute pressure of the steam in pounds per square inch, multiplied by the area of the orifice in square inches, divided by 70. Since this is only a close approximation it is sufficiently accurate to figure the absolute pressure by adding 15 to the gage pressure. Napier's rule does not apply if the absolute pressure on the exhaust side of the orifice is more than 0.6 of that on the high-pressure side. In the case of steam blowing into the atmosphere, this means that the rule should not be used if the steam pressure is less than 10 lb. per square inch, gage.

The use of rubbish as fuel in the production of electric power is under consideration in Tokyo, where it is estimated that about 6,000 kw. can be developed from the 1,000 tons per day of available waste.

QUESTIONS AND ANSWERS



Kerosene May Cause Boiler Leaks

Is there any objection to use of kerosene in a fire-tube boiler to loosen the scale from the tube surfaces before turbining the tubes, and can any damage to the boiler plate result from such use of kerosene? E. W.

Kerosene is harmless to boiler plates. The principal objection to its use in boilers is that it may cause leaks at tube ends and joints in the shell plates by softening rust or scale where they may be beneficial for keeping a joint tight. A leak thus caused by kerosene usually is difficult to stop, for it cannot be made tight until the boiler is thoroughly clean of the oil and all traces of it have been removed from the sides of the leak.

Mechanical Efficiency of Engine

An engine that develops 602 hp. is belted to an electric generator that turns out 1,500 amperes 240 volts. The efficiency of the belt is 96 per cent and that of the generator is 92 per cent. What is the mechanical efficiency of the engine? M. J.

The net output by the generator would be 1,500 amperes $\times$ 240 volts $\div$ 1,000 = 360 kw., or 360 $\div$ 0.746 = 482.57 horsepower. Having a generator efficiency of 92 per cent, and efficiency of belt 96 per cent, the net horsepower developed by the engine would be $\frac{482.57}{0.92 \times 0.96} = 546.39$ brake horsepower. Hence, if the power developed in the cylinder of the engine is 602 i.hp., the mechanical efficiency of the engine would be 546.39 $\div$ 602 = 0.9076, or 90.76 per cent.

Draft as Affected by Temperature of Chimney Gases

Does the draft of a chimney increase with the temperature of the gases as well as the height? R. G. N.

The force or pressure of draft is due to the difference of densities of the chimney's gases and the density of the atmosphere. As the density of the chimney gases decreases with increase of temperature, it follows that for a given atmospheric condition the higher the temperature of the chimney gases the higher the draft pressure. But for internal chimney temperatures above 622 and average atmospheric conditions, the densities of the gases decrease faster than the velocity increases, so that the quantity or weight of gases passing up the chimney is a maximum at about this temperature; and within reasonable limits the draft pressure increases with the height of the chimney.

Temperature of Feed Water for Cast-Iron Boiler

What is the lowest temperature of feed water that would be safe to admit to a cast-iron boiler carrying 25 lb. gage pressure? G. C.

The safe difference between the temperature of the steam and that of feed water supplied to a cast-iron boiler depends on the form and the method of connecting the sections, the part of the boiler where the feed water is admitted, the freedom of the castings to expand and contract from changes of temperature, and the rate of feeding compared with the volume of water in the boiler. Ordinarily, it is safe to have the feed water 180 deg. F. below the temperature corresponding with the pressure. Steam at 25 lb. gage has a temperature of 268 deg. F., and a cast-iron boiler of ordinary design carrying that pressure should be safe against rupture from lowering of the temperature by admitting feed water at the usual rate when the temperature of the feed is not lower than 268 — 180 = 88 deg. F.

Speed of Oiling Ring

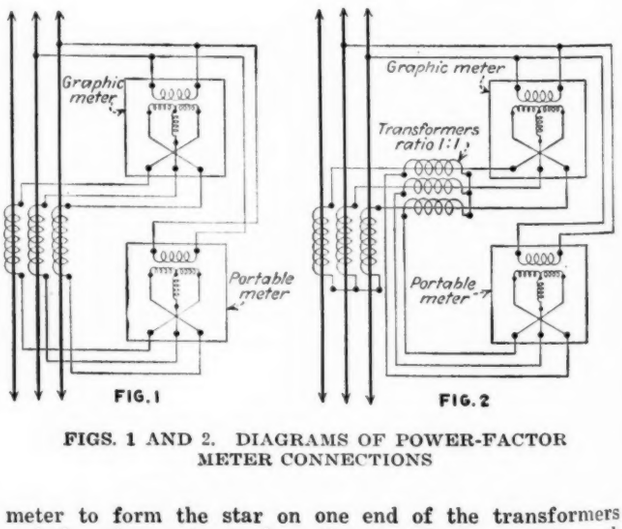
In a bearing that is provided with ring-feed lubrication, does the oil ring travel as fast as the shaft? A. O.

The oil ring receives its motion from frictional contact with the shaft. The only condition under which it could travel as fast as the shaft would be when the weight of the ring or character of the surfaces is such that the friction or interlocking projections of the surfaces like gear teeth in true rolling contact would be sufficient to overcome the resistance of drawing the ring around through the oil and lift the oil taken up by the ring. Although these resistances may be very small they always are sufficient to cause the inner circle of the ring to travel slower than the surface of the shaft by which the ring is supported.

Graphic Power-Factor Meter Connections

We have a Westinghouse graphic power-factor meter which has three current coils connected in star and a portable power factor meter with the same connection. How is it possible to connect two star-connected meters in series for testing purposes? M. E. W.

Assuming that the current is obtained from the secondary of series transformers, it is only necessary to connect one meter to form the star on one end of the transformers and the other meter to form the star on the opposite end. This connection is shown in Fig. 1. It is necessary to



FIGS. 1 AND 2. DIAGRAMS OF POWER-FACTOR METER CONNECTIONS

reverse the potential winding in one instrument to maintain the correct phase relations.

If both ends of the series transformer secondaries are not available, then portable transformers having a ratio of 1 to 1 may be used with the connection as in Fig. 2.

Why Single Riveting is Sufficient for Girth Joints

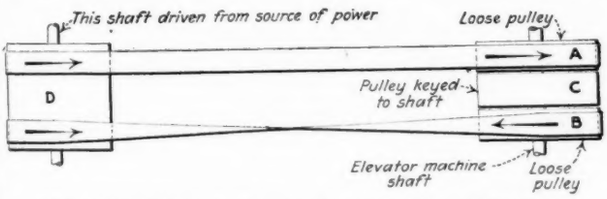
Why are girth seams of a return-tubular boiler only single-riveted, while the longitudinal seams may be required to be triple-riveted? H. L.

Without allowing for any assistance rendered by the tubes, braces or stays, the strength required per unit of length of a girth seam is only one-half as much as for the same unit of length of a longitudinal joint. The total pressure resisted by a complete girth seam of a boiler would be the square inches of projected area of a head, multiplied by the pressure per square inch, or $\frac{1}{4}$ *diameter in inches* $\times$ $\frac{1}{4}$ *circumference in inches* $\times$ *pressure per square inch*, and the stress per inch length of the joint would be $\frac{1}{4}$ *diameter in inches* $\times$ $\frac{1}{4}$ *circumference in inches* $\times$ *pressure per square inch* $\div$ *circumference in inches* = $\frac{1}{4}$ *diameter in inches* $\times$ *pressure per square inch*. The total pressure resisted by a longitudinal seam is $\frac{1}{2}$ *of the diameter of the boiler in inches* $\times$ *length of joint in inches* $\times$ *pressure per square inch*, as described page 305, Aug. 23 issue of *Power*, and the stress per inch length of the joint would be $\frac{1}{2}$ *diameter in inches* $\times$ *pressure per square inch*, or twice as much as the stress per inch of length of a girth joint.

Double Belt-Driven Elevator

How is the rotation of a double-belt elevator machine reversed? What would happen if the straight and cross belts of the machine were interchanged? R. A. S.

On the driving shaft of a double-belt elevator machine there are three pulleys; namely, two loose, *A* and *B*, and a third pulley, *C*, keyed to the shaft, as shown in the figure. The source of motive power for driving the machine is connected to a jackshaft on which is mounted a wide-faced pulley, *D*. The width of the face on this pulley is equal to or greater than the combined lengths



ARRANGEMENT OF BELT DRIVE FOR ELEVATOR

of *A*, *B* and *C*. Two belts, one straight and one crossed, connect *D* with the elevator machine. With the operating mechanism in the neutral position the two belts are located as indicated in the figure; that is, on the loose pulleys and the elevator machine is at rest.

Assume that the top of the driving pulley *D* is turning to the right, then *A* will be turning to the right also and *C* to the left. The operating mechanism is so arranged that when the operating cable is pulled to one motion one belt is shifted to pulley *C*, and when the cable is pulled to the other position the other belt is shifted onto *C*. It is evident that when the straight belt is shifted from pulley *A* onto *C*, the elevator shaft will be given opposite rotation to that when the crossed belt is shifted from *B* onto *C*. If the belt arrangement shown in the figure drives the machine in the right direction, then if the belts are interchanged the elevator will be driven in the wrong direction. In other words, when the operating-cable is pulled to the down position the car will go up and when pulled to the up position the car will go down. Under such a condition if the machine is allowed to run on the limit, instead of their stopping the machine they will prevent it from being stopped, and will generally result in a serious wreck, since either the counterweights or the car will be pulled into the overhead work.

Connecting Lamps in Series

What would be the result of connecting a 100-watt 120-volt lamp in series with a 60-watt 120-volt lamp, on a 240-volt circuit? A. R. L.

On account of the low-wattage lamp having the highest resistance it will be subjected to more than one-half the voltage. This is explained as follows:

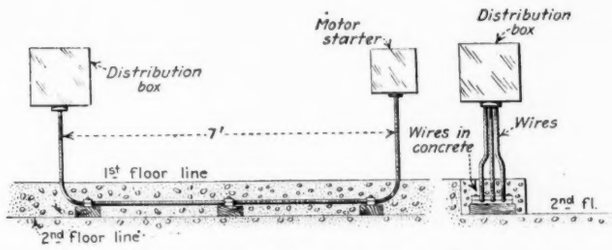
The resistance of the 100-watt lamp equals (*volts* $\div$ *Watts*) = (120 $\times$ 120) $\div$ 100 = 144 ohms, and the resistance of the 60-watt lamp equals (120 $\times$ 120) $\div$ 60 = 240 ohms, making the total resistance for the two lamps, when connected in series equal to 144 + 240 = 384 ohms. The current taken by the lamps is equal to line *volts* $\div$ *ohms* = 240 $\div$ 384 = 0.625 ampere. Volts impressed across the 100-watt lamp equals *ohms* $\times$ *amperes* = 144 $\times$ 0.625 = 90, and volts impressed across the 60-watt lamp equals 240 $\times$ 0.625 = 150. This gives a condition, in one case, of the 120-volt lamp operating on 90 volts and in the other a 120-volt lamp operating on 150 volts. In the former the lamp will be dim and in the latter it will be too bright.

Looking at this problem another way, the normal current of the 100-watt lamp equals *watts* $\div$ *volts* = 100 $\div$ 120 = 0.833 ampere and for the 60-watt lamp *normal current* = 60 $\div$ 120 = 0.5 ampere. Comparing these current values (0.833 and 0.5) with that passing through the lamps (0.625) when connected in series, it is seen that the current through the high-wattage lamp is low and through the low-wattage lamp the current value is high, which would produce the results referred to in the foregoing.

Wires Laid in Concrete

In our plant we have a 40-hp. 200-volt 50-cycle three-phase slip-ring induction motor. The connections from the distribution box to the starting box, a distance of 7 ft., have been made as in the figure. The wires were laid on a concrete floor, supported by cleats placed on wooden blocks, and were then concreted over. Is this plan safe, and what results are to be expected? O. J.

The construction shown in the figure is not to be recommended, since first of all it would not be passed by the inspection department of the Fire Underwriters. Probably no bad effects would result from pouring the wet concrete



HOW WIRES WERE LAID IN CONCRETE

around the wires, but serious corrosion has occurred in less favorable conditions, which eventually caused an open-circuit. In case of trouble on the cables it would be necessary to tear up the concrete to get the wires out. Where the wires are brought out of the concrete no protection has been provided, therefore the insulation is liable to injury. When the insulation gets in poor condition the salts on the floor are sufficient to cause leakage between conductors and may in damp places cause short-circuits. On the other hand, if a ground occurred in the controller anyone standing on the floor near the conductors and happening to come in contact with the controller might receive a severe shock.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Interpretations of the A. S. M. E. Boiler Code

REQUESTS for interpretations of the Boiler Code are acted upon by the Boiler Committee, their formulated replies being submitted to the Council of the American Society of Mechanical Engineers. The inquiries and replies are published from time to time in *Power*, with such explanatory comments and illustrations as seem advisable for a clear understanding of the interpretations on the part of engineers in general. The last group of interpretations published in *Power* was in the issue of Aug. 23, 1921.

Case No. 357—Inquiry: Are the circulating pipes connecting down-draft furnaces to the shells of boilers to be considered as integral parts of the boilers themselves, or as connecting piping outside of the boiler? Screwed connections as now used give both economy in space and flexibility.

Reply: It is the opinion of the committee that such connections between boiler shells and down-draft furnaces are integral parts of the boiler, so that the requirements in Par. 268 for pipe openings leading from a boiler need not be met, and screwed connections may be used. The requirements for the minimum number of threads given in Table 8 apply to all pipe connections and should be met, as well as all other requirements which bear on the structure.

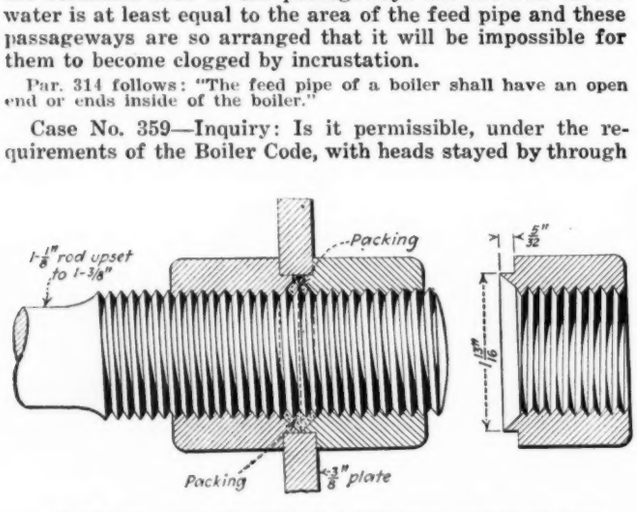
Par. 268 gives the requirements of threaded openings for pipe connections. These requirements cover the number of threads per inch and the minimum depth of the threaded hole, both of which are given in Table 8. The reply indicates that the above requirements hold in this case, but that the last part of Paragraph 268 (specifying flanged connections for pipe openings over 3-in. pipe size where the pressure is more than 100 lb. per sq.in.) does not apply in this case.

Case No. 358—Inquiry: Is it permissible, under the requirements of the Boiler Code, to deliver feed water into the shell of a boiler through what is known as an induction valve or spray nozzle located in the steam space and arranged to deliver the water through a number of constricted openings in the form of a spray.

Reply: It is the opinion of the committee that such an arrangement at the end of the feed pipe for delivery of the feed water to the boiler will not meet the requirement of Par. 314, which requires that the feed pipe shall have an open end or ends to prevent stoppage by incrustation, unless the combined area of the passageways for the flow of the water is at least equal to the area of the feed pipe and these passageways are so arranged that it will be impossible for them to become clogged by incrustation.

Par. 314 follows: "The feed pipe of a boiler shall have an open end or ends inside of the boiler."

Case No. 359—Inquiry: Is it permissible, under the requirements of the Boiler Code, with heads stayed by through



(CASE NO. 359) THROUGH STAY ROD WITH GLAND NUTS OF SPECIAL DESIGN

rods, to attach the rod ends to the heads by a special form of gland nuts that provide for packing between them, as shown in Fig. 1.

Reply: It is the opinion of the Boiler Code Committee that this construction does not conflict with the requirements of the Boiler Code, provided that the area of the nut bearing surface against the plate is greater than the minimum cross-sectional area of the rod. The value of C for this construction shall be 135.

Par. 199 gives the formula for the permissible pressure on stayed surfaces. (*C*) is a constant in this formula.

Case No. 360—Inquiry: Is it necessary, under Par. 254, to remove heads, open up girth seams and remove manhole frames, braces, etc., in order to remove burrs formed by drilling or reaming of rivet holes?

Reply: Par. 254 refers specifically to the plates and butt straps at longitudinal joints.

Par. 254 reads as follows: "After drilling or reaming rivet holes the plates and butt straps shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fittings the holes, and with tack bolts."

Case No. 361 annulled.

Case No. 362—Inquiry: (a) What is the minimum thickness of plates used for dome heads that is permitted under the requirements of the A. S. M. E. Boiler Code? (b) Is it permissible to stay the heads of domes, where they are flat, by using angle or channel irons?

Reply: (a) There is no limit specified in the code for the minimum thickness of dome heads except as given in Par. 17. (b) The heads of domes, if flat, shall be stayed in accordance with Par. 199 to 233 inclusive.

Par. 17 provides that "the minimum thickness of any boiler plate under pressure shall be ¼ inch.

Par. 199 to 233 give the rules and formulas regarding the various methods of supporting flat surfaces, including the use of angle braces.

Case No. 363—Inquiry: Is it permissible, under the requirements of the Boiler Code, to apply a manhole in the upper head of an h.r.t. boiler over 40 in. in diameter, the area of the head surrounding the manhole to be stayed as provided in Par. 203e?

Reply: In accordance with Par. 264, a manhole shall be placed in the upper part of the boiler shell, boiler head or dome head, of a fire-tube boiler over 40 in. in diameter. When applied to the head of such a boiler, the head shall be stayed in accordance with Par. 203e and 214, and the others applying to stayed surfaces.

Par. 264 specifies the following manhole and handhole requirements for h.r.t. boilers:

(a) A boiler 48 in. or over in diameter shall have a manhole in the front head below the tubes. Smaller boilers shall have either a manhole or a handhole below the tubes.

(b) A boiler over 40 in. in diameter shall have a manhole above the tubes. This may be located in the shell, head or dome. Smaller boilers shall have either a manhole or a handhole above the tubes.

Colfax Station Featured Before Chicago A. S. M. E.

On Oct. 17 the Chicago Section of the American Society of Mechanical Engineers held the first dinner meeting of the season at the Chicago Engineers' Club. The topic of the evening, the new Colfax Station serving the Pittsburgh District, proved popular, and Chairman David Lofts had the pleasure of welcoming an excellent attendance. From descriptions appearing in *Power* earlier in the year, it will be remembered that the Colfax Station is one of the most modern mine-mouth plants in the country and has the exceptional advantages of ample quantities of coal and water close at hand and a location in the heart of a great industrial center. The station now has one 60,000-kw. generating unit, consisting of a three-cylinder cross-compound turbine driving three 20,000-kw. 12,000-volt generators, and seven cross-drum boilers, each having 20,876 sq.ft. of heating surface. The ultimate capacity, with six of these units, will be 300,000 kw., one being held in reserve.

W. C. Clarke and D. L. Galusha, of the Dwight P. Robinson Co., designers and builders of the station, gave the details of construction and the features of the station largely by means of lantern slides supplemented by two motion-picture reels, which brought out to better advantage the construction work, the difficulties that had to be overcome and the main features of the station. Mr. Clarke detailed the mechanical end and Mr. Galusha the electrical work.

Pipe-Line Transportation for Anthracite and Bituminous Coal*

A Discussion of a Plan of Pumping Coal from the Coal Fields to New York, with Data Supporting the Claim of Feasibility

By GEORGE A. ORROK and W. S. MORRISON

THE transportation of material in a more or less finely divided state by a stream of water has long been known and practiced, hydraulic mining having been invented comparatively early from the analogy of the rapid erosion seen on streams of heavy slope. The suction dredge followed and has been developed to a high degree of efficiency in handling the materials that compose most of our river and harbor bottoms. Although ordinarily designed to pump only sand and mud, it was soon found that much larger materials were rapidly and easily transported, the main criterion being the size of the passages in the pump and cutter which loosened the material. The vast deposits of phosphate rock in Florida, which are mostly under water, brought the development of this method of handling to a high stage of perfection.

TABLE I. OPERATING COST OF TRANSPORTING COAL BY PIPE LINE

Route No.	1	2	3
Kw. required	33,000	49,500	83,380
Kw. installed	4–10,000	4–15,000	5–20,000
Output 90% on req.	260,000,000	390,000,000	660,000,000
Use factor, per cent	74	74	75
Generating cost	0.5c.	0.45c.	0.4c.
Dollars per year	$1,300,000	$1,755,000	$2,640,000
No. substations	73	111	186
4,000 sub			
Labor at 2,500 line	465,000	721,500	1,210,000
6,500			
Repairs—lumped	150,000	250,000	400,000
Terminal labor and repairs	200,000	200,000	500,000
Administration	200,000	200,000	250,000
Total operating	$2,315,000	$3,126,500	$5,000,000
6,000,000 tons (per ton)	38.58c.	52.11c.	83.3c.

The earliest proposal to pump coal in this manner was made by W. C. Andrews in the early 90's. He broadly patented the method of pumping coal through pipe lines and made some experiments as to the practicability of his invention. His process was used to some extent in the anthracite regions for pumping the culm and waste back into the worked-out portions of the mine, filling them to prevent falling of the roof, and this was practiced for quite a number of years before the value of the finer sizes of coal was demonstrated. At the present time suction dredges are working in the rivers in the anthracite region, removing the fine coal that has been wasted into the bed of the river. Andrews apparently made no attempt to push or perfect his patents and they have now expired. Later, around 1905, W. T. Donnelly, after a number of experiments, patented a method of controlling the flow and found the most efficient sizes of the coal particles as well as the proportion of water to coal for the best operation. These patents are still alive.

In the handling of coal hydraulically, criticism has been directed toward the fact that the sulphur content in the coal, combining in solution with the carrying fluid, will have a deteriorating effect on the pumps and pipe lines. Sufficient work has been done to justify the conclusion that the introduction of lime or other acid-neutralizing agents into the water at the sending end of the system will obviate this difficulty.

As coal has a specific gravity of one and six-tenths, about four-tenths of its weight is borne by the water it displaces and the passage of a mixture of 50 per cent coal and water should offer only slightly greater frictional resistance than that of water carrying mud and sand. The water will probably contain a sufficient quantity of finely divided particles of coal to increase its specific gravity and correspondingly increase its carrying capacity. In addition, the fine coal held in suspension should impart to the mixture something of the lubricating quality of graphite. In the handling of phosphate rock through pipe, it has been observed that the loss due to friction is about 15 per cent greater than that for clear water.

At each relay station there is to be installed four separate single-stage pumping units each direct-connected to its own motor. The units are arranged to operate in pairs, in series with each other with the discharge from the first pump, taking its supply from the line, connected to the suction of the second, the discharge from the second delivering into the pipe main. One pair of pumps is intended to serve as spare units to carry the station in case of serious accident or shutdown for repairs on any of the others. Provision is made for bypassing each station. Large-opening, quick-acting relief valves are provided at the inlet and discharge ends of each station to prevent injury to the pumps in case of a "blow back" or ram. In the detail design of certain of the relay stations it may be considered advisable to install a sump or receiving pit from which the coal can be drawn instead of delivering direct through the pipe lines to the suction inlet of the pumps.

On the data covering operating cost are shown the characteristics of the power stations which will be needed for the several routes, the outputs being based on a use factor of about 75 per cent. This shows the number of pumping stations, the prices which have been allowed in each case for substation and terminal labor and repair and an allowance for administration. Route 1 is from Scranton to Piermont on the Hudson, length of line, 130 miles; Route 2 is from Scranton to Newark Meadows, distance 195 miles; Route 3 is from Clearfield to Piermont via Scranton, distance 322 miles.

It will be seen that in the case of Route No. 1 the operating charge figures up to around 38.6c. per ton, while with the bituminous-coal Route 3 the charges are around 83 cents.

TABLE II. PLANT COST OF PIPE LINE AND STATIONS

Route No.	1	2	3
Pipe	$3,000,000	$,500,000	$9,500,000
Laying and haulage, etc.	750,000	1,110,000	1,800,000
Transmission line	1,560,000	1,346,000	3,864,000
Pumping stations	1,230,000	1,870,000	3,232,000
Power plants	3,300,000	4,950,000	8,338,000
Real estate	160,000	237,000	390,000
Terminals	550,000	550,000	550,000
Totals	$10,550,000	$15,563,000	$27,674,000
Contingencies, engineering and patents	1,550,000	2,337,000	4,156,000
Estimated cost	12,100,000	17,900,000	31,830,000
Fixed charge s12%	1,452,000	2,148,000	3,820,000
Per ton	$0.242	$0.358	$0.6367
Operating charges	2,315,000	3,126,000	5,000,000
Per ton	$0.386	$0.521	$0.833
Total cost per ton	$0.628	$0.879	$1.47
Present freight rate	*2.63	*2.63	†3.46
Margin for profit	2.00	1.754	1.99

*Anthracite at $2.56 plus 3 per cent war tax.
†Bituminous at $3.36 plus 3 per cent war tax.

Under the heading of plant cost are included the estimates for installations which range from $12,100,000 for Route No. 1 to $31,830,000 for Route No. 3. The fixed charges and operating charges together give the total cost for handling and delivering the coal at the Hudson River Terminal. This varies from 62.8c. for Route No. 1 to $1.47 for Route No. 3.

Each 14-in. pipe line can handle an average of 6,000,000 tons of coal per year and three of such lines would prob-

*Extracts from an Address before the Association of Edison Illuminating Companies at Convention held at Spring Lake, N. J., Sept. 12, 1921.

ably provide for the entire New York supply of both anthracite and bituminous coal. The coal must proceed from the mine to the Hudson at a nearly uniform rate for good efficiency, as shutdowns on a system of this kind would be costly and troublesome.

The cost of the necessary water is not included. In some cases it might run up into very considerable figures, particularly so, for instance, in the Lehigh District where the source of coal supply is mainly on the hill tops. The actual cost of this supply can be determined only when proper surveys are made.

Lubrication Engineers Hold First Convention

About a year ago a small group of men met in Chicago to organize a society devoted to the scientific application, conservation, reclamation and handling of lubricants and liquid fuels. The need for such an organization to bring about a better understanding of the fundamentals of these subjects was evident, and it was felt that the field was big enough and of sufficient importance to warrant a distinctive organization, national in its scope, devoted to this work. Officers, including a board of directors, were selected, the constitution and by-laws were drawn up, the publication of a monthly journal started and an active campaign for membership inaugurated.

The membership now totals 90, but interest is so widespread throughout the country that prospects are bright for a much larger organization within the next year. The plan is to enlarge the board of directors to include representative engineers of the largest industries in the country, the army, the navy and fuel and lubrication authorities. Branches are to be formed in the principal cities or industrial centers and divisions established to best serve the individual industry or related groups of industries. All interested in the manufacture, application, reclamation or handling of petroleum products, as well as those engaged in research or educational work along these lines, are eligible to membership. The society is purely professional and technical in its nature. The present officers are: President, William F. Parish, consulting lubrication engineer, Chicago; first vice-president, Carver Wood, conservation engineer of the Wayne Oil Pump and Tank Co.; second vice-president, N. M. Griffin, vice-president of Mack-International Motor Truck Co.; executive secretary, J. L. Overholt, Chicago. Directors: H. Sheldon Clark, vice-president, Sinclair Refining Co.; W. H. Bailey, chief engineer, Illinois Steel Co.; J. J. Connelly, engineer of S. F. Bowser Co.; J. W. Stack, engineer Standard Oil Co. of Indiana; C. B. O'Hare, of C. B. O'Hare Co.

On Oct. 12 and 13 the society held its first annual convention jointly with the Independent Oil Men's Association at the Drake Hotel, Chicago. There were two technical sessions at which a number of interesting papers were presented. The attendance approximated fifty and all present seemed enthusiastic over the prospects for the future.

In the opening address President W. F. Parish traced the chaotic conditions that had developed in the oil business and the simplification that had been brought about by the lubrication engineer. At present the great mass of machines fall within the range of a light, medium or heavy oil, although the grade or character of the oil can be different for each classification. Oils can be produced cheaply and the same oils can be worked over and finished into better lubricants without materially changing the physical characteristics, but increasing the cost to the consumer. It is the duty of the lubrication engineer to determine whether the increased cost is justified and to select the best lubricant for the specific service.

In a paper on "The Status of Lubrication Engineering," W. H. Bailey pointed out that the greatest waste in petroleum products today is in lubricants, the most costly and valuable derivative of petroleum. The waste takes place in all the industries and comes about largely through lack of sound practical and scientific knowledge on the application and selection of lubricants and methods of handling and reclaiming. Hence the need for an association to bring about a better understanding of the fundamentals, and by an exchange of ideas and technical data to advance this important branch of engineering. The author outlined the aims and objects of the new society and the plans to be followed to fulfill its mission.

Dr. W. F. Faragher, of the Mellon Institute of Industrial Research, told what the oil analyst did in the laboratory and suggested what the lubrication engineer might do in the field. An analysis was traced step by step, with full discussion on fire and flash points, specific gravity, etc.

"Electric Railway Lubrication" was discussed by Dean Treat, now lubrication engineer of the Standard Oil Co. of Indiana, after which C. M. Larson, of the Sinclair Refining Co., presented a paper on the dilution of crankcase oil in automobile engines.

In an interesting address Professor Berry told what the carburetor engineer is doing in trying to eliminate the difficulties imposed by the "heavy ends" in present-day fuel, as there need be no expectation of going back to the lighter gasolines available years ago. In this work the co-operation of the lubrication engineer is needed, and perhaps some of the trouble might be eliminated if the oil refiner fully understood the requirements. A number of charts were presented showing the effect on horsepower and efficiency by increasing the temperature of the air passing through the carburetor. The objections to the present form of manifold were emphasized and results given from experiments with a hot plate located in the manifold to insure a vapor fuel.

E. L. Gross, vice-president of the Perolin Company of America, discussed the effects of boiler foaming on cylinder lubrication. The cause of foaming was explained, and suggestions made on prevention.

"Theory of Lubrication," by President W. F. Parish, was the final paper of the session. The paper explained in a simple manner the theory of lubrication, taking up the two functions of a lubricant: Keeping the surfaces apart and conveying from these surfaces heat that is caused by friction. Data on the cotton spindle, the lightest type of general machinery to lubricate and therefore the most sensitive, were given to show the effects of improved lubrication, denoted by a reduction in power, a reduction in temperature and an increase in speed. Reference was made also to a 10,000-hp. reversing mill engine in which a change in the manner and method of lubrication effected a saving of nearly 1,000 hp. by reducing the friction load 80 per cent.

Officers for the coming year were not elected during the convention, but a slate is being considered and it is the expectation that by the first of the year the organization will have had an opportunity to express a choice.

Good Progress Reported on Hydro Plant at Duncan's Riffle

Preliminary work looking to the construction of the big dam at Duncan's Riffle, on the Coosa River, fifty miles south of Birmingham, is progressing with good speed. Col. R. A. Mitchell, vice-president of the Alabama Power Co., which is responsibile for the project, has announced that thirty-five houses have already been built at the riffle for the accommodation of their employees. A big mess hall has also been provided for the 500 men now at work.

Several sawmills are in operation, cutting lumber for the construction of necessary buildings. The company is also building a railroad from Cooper, on the main line of the Louisville & Nashville R. R., to the riffle, a distance of 8½ miles. About two miles of this road has already been built, and about a quarter of a mile is being constructed daily. The road will be owned by the power company. An electric line has been constructed to the river, and power and lights are now available at the riffle.

It is estimated that it will require about two years to complete the dam, and that it will cost upward of $8,000,000, making 100,000 hp. available.

Washington News

Conference on Ford Offer for Muscle Shoals—Coal Storage Advised—Chamber of Commerce Studying Natural Resources

By Paul Wooton
Washington Correspondent

Following a conference in Washington Oct. 24 between the Secretary of War, the Secretary of Commerce, Brig. Gen. Harry Taylor, W. B. Mayo, and Col. J. W. Worthington, Secretary Weeks declared that definite progress is being made and that the difference between the estimates of the Army engineers and the Ford engineers on the cost of the completion of the Wilson dam and the construction of dam No. 3 has been narrowed materially. Secretary Weeks stated than no bargaining was attempted at this conference, as that would be done between Mr. Ford and himself shortly after he has looked over the project personally, but his attitude indicated plainly that he is much more favorably impressed with the proposition in its present form that at any previous time.

Secretary Weeks took pains to point out that a portion of the difference between the estimates of the cost of completing the Wilson dam and the construction of dam No. 3 can be accounted for by the difference in costs at the times the estimates were made and by the fact that the Army estimates cover a better type of construction than is absolutely necessary. He said that there is the greatest eagerness on the part of contractors to undertake work at this time and that, as a result, advantageous arrangements can now be made with them.

While Secretary Weeks agreed that the reopening of the work would put smoke in many chimneys and would help the unemployment situation, he said that he could not agree with statements attributed to Mr. Ford as to the extent that active work on this project will stimulate industry.

Storage of Coal

In indorsing the statement made at Chicago by Director Smith of the United States Geological Survey in regard to leaks in the coal industry, Harry Taylor, former president of the National Coal Association in a letter to Dr. Smith says among other things:

You have covered that situation in a clear and concise manner and it is generally understood by operating men that the buyer of coal is often unwilling to recognize the invisible increase in cost caused by lack of running done and irregular distribution of work at mines. Again, this is a matter the public can cure if we can ever arouse the public to its self-interest in a more regular placing of orders throughout the twelve months of the year. I read the letter from President Harding to the Mining Congress, in which he suggests storage. I believe, if the consuming public thoroughly understood the economic waste involved in the irregular distribution of coal and the saving that could be made in the country if the industry could function every month in the year, that they would give serious consideration to the storage of coal and its direct effect on the cost of production.

Work of the Chamber of Commerce

Half of the difficulties of the natural resource industries would disappear if the public were well educated in their problems. This is the opinion of W. Du B. Brookings, the head of the Natural Resource Production department of the Chamber of Commerce of the United States. This department is preparing an active program in an effort to render constructive service to the raw-material industries. The organization of the department is just being perfected. An advisory committee has been named, of which C. S. Keith, the president of the Central Coal and Coke Co. of Kansas City, is chairman.

It is the opinion of Mr. Brookings that nothing is of more importance in this day, with its tendencies toward Federal regulation of business, than to secure for the natural-resource industries a high degree of public confidence. This, he believes, can be obtained if the public knows the real facts in regard to these industries.

Mr. Brookings is a retired California lumberman. Throughout his business career, however, he has been interested in coal, oil, natural gas, water power and other natural resources, and has made a personal survey of the timber and power resources in both the United States and Canada.

The Engineer as Seen by a Sculptress

With cubism, impressionism, and other eccentricities of modern art, the readers of *Power* presumably have no interest; but when art assumes the responsibility of creating and putting before the public a statue that is evidently intended to be symbolical of the engineering profession, then the matter becomes of keen interest to all who are engineers or whose sympathies lie with the profession. Of such a nature is a work of art that has recently been receiving attention.

The result of this artistic trespass upon strange ground is somewhat surprising, as may be seen from the accompanying photograph of the statue in question, the title of which is "The Engineer." Perhaps a partial explanation of the profound ignorance of prosaic engineering subjects disclosed by the statue may lie in the fact that it is a feminine conception. The sculptress is Mrs. Harry Payne Whitney, and her work has recently been presented as part of an exhibition of the National Association of Women Painters and Sculptors. It would be of interest to learn what Mrs. Whitney's sentiments would be if she were to come upon a statue of a granite-worker trimming the edges of a tombstone, entitled "The Sculptor."

THE ENGINEER(?)

An unusual accident occurred recently when a lightning flash struck the power line feeding one of the electrically driven pumping stations in Minneapolis. The circuit breakers were thrown out, and two 50 m.g.d. centrifugal pumps stopped suddenly. The resulting water hammer burst the bonnet of a 42-in. valve on a header at the plant, and also burst 16 ft. of lock bar on the steel delivery pipe half a mile away from the plant. This, of course, was incomprehensible to the newspapers, which reported that the pipe line had been struck by lightning.

An underground pumping plant that is said to be one of the largest of its type in existence is described in the October issue of the *General Electric Review*. The installation is in a gold mine in South Africa, and has a capacity of 8,000,000 gal. per day against the extremely high head of 2,600 ft.

Stoker Manufacturers Meet

The Fall Meeting of the Stoker Manufacturers' Association assembled at Buckwood Inn, Shawnee-on-Delaware, Oct. 18-20, some 70 representatives of member companies and guests being present.

On Tuesday morning President Maxwell Alpern presented his address. An exceptionally interesting paper on "The Necessity for and Savings Possible with Better Boiler Room Operation"—which we are privileged to present in an early issue—was read by C. W. DeForest, of the Union Gas and Electric Co., Cincinnati. In the evening reports of the Research and other committees were considered.

On Wednesday H. F. Hagan, representative of the National Association of Fan Manufacturers, presented a paper outlining the "Uses of and Character of Equipment Required for Blast and Induced-Draft Stokers," after the discussion of which the reports of several committees were disposed of.

Thursday forenoon the association heard the reports of its committees of conference with other associations. With the American Boiler Manufacturers' Association they had discussed the matter of a standard front for water-tube boilers. With the Committee on Power Test Codes of the A. S. M. E. they had discussed the revision of the Boiler Test Code. With the Fuel Division of the A. S. M. E. they had arranged for a series of stoker papers to be presented at the spring meeting of the Division. Their own Engineering Committee had made an extensive study of stoker auxiliaries. S. L. Nicholson gave the results of a conference with Secretary Hoover as to how the Stoker Manufacturers' and similar associations could best profit by and be of service in the activities of the Department of Commerce.

For entertainment there was an auto ride for the ladies, a banquet, conducted in his inimitable style by the secretary, Joe Worker, and several golf tournaments over the beautiful Shawnee course.

The association is to be congratulated upon having effected an organization which, if carried on along the lines of this meeting, will accelerate the evolution of the art, result in greater adaptability of stokers to their particular work, greater boiler-room efficiency and greater convenience and economy for their users.

The following are the committees and the member companies:

Executive Committee: M. Alpern, president; S. A. Armstrong, vice president; Richard D. Hatton, treasurer; R. Sanford Riley; A. G. Pratt; J. G. Worker, Secretary.

Engineering: John Van Brunt, chairman; N. E. Lewis, R. A. Foresman, T. A. Marsh, E. Fitts.

Underfeed: R. A. Foresman, chairman; A. H. Blackburn H. F. Lawrence.

Chain Grates: T. A. Marsh, chairman; L. R. Stowe, J. Harrington, W. H. Wood.

Side Feed: E. Fitts, chairman; G. I. Bouton.

A. S. M. E. Conference: L R. Stowe, chairman; F. H. Daniels, F. C. Armstead.

Cost Accounting: W. V. Sauter, chairman; A. G. Pratt, W. V. McAllister, W. H. Reicks.

Research: Joseph Harrington, chairman.

Engineering Section: A. D. Pratt, R. L. Beers, H. F. Lawrence.

Commercial Section: L. Stowe, F. A. DeBoos, J. A. Flemings, H. N. Scofield.

Commercial: F. B. Bigelow, chairman; P. A. Poppenhusen, S. A. Armstrong, W. H. Rea, G. A. Sacchi, G. E. Learnard, George W. Barr.

Publicity: P. A. Poppenhusen, chairman; R. C. Beadle, R. D. Hatton, R. T. Gray.

Traffic: G. A. Sacchi, chairman; J. T. Arnold, A. V. Pope, C. W. Baldwin.

Statistics: W. H. Rea, chairman.

Member Companies: American Engineering Co., Philadelphia, Pa.; Babcock & Wilcox Co., New York City; B. F. Sturtevant Co., Boston, Mass.; Burke Furnace Co., Chicago, Ill.; Combustion Engineering Corp., New York City; Detroit Stoker Co., Detroit, Mich.; Green Engineering Co., East Chicago, Ind.; Illinois Stoker Co., Alton, Ill.; James A. Brady Foundry Co., Chicago, Ill.; Joseph H. Roach & Co., Inc., Philadelphia, Pa.; Laclede Christy Co., St. Louis, Mo.; Murphy Iron Works, Detroit, Mich.; Sanford Riley Stoker Co., Worcester, Mass.; Underfeed Stoker Co. of America, Detroit, Mich.; Westinghouse Electric & Manufacturing Co., E. Pittsburgh, Pa.

News in the Field of Power

Obituary

Prof. Alexander Gray, director of the School of Electrical Engineering of Cornell University, died after a long illness on Oct. 13. He was born in Edinburgh, Scotland, and became an apprentice at the age of fifteen, serving for seven years in the shop and drafting-room. He was graduated in 1902 from Edinburgh University in civil and mechanical engineering and received the Whitworth scholarship, under which he spent two years in electrical engineering at McGill University, Montreal, Canada. Later, he worked on the engineering staff of the Bullock Electric Co. as head of the alternating-current motor department, remaining there after the consolidation with the Allis-Chalmers Co. In 1910 he returned to McGill University as assistant professor, leaving there in 1915 for Cornell. He held a number of patents for electrical apparatus and was the author of two well-known textbooks: "Electrical Machine Design" and "Principles and Practice of Electrical Engineering."

George R. Henderson died recently of septic pneumonia at the Hotel Idlewild, Media, Penn. He was sixty years of age, and had retired from active work about two years ago, although he had more recently been doing some consulting work. He was born and educated in Philadelphia, and served his apprenticeship with the Pennsylvania Railroad Co. He remained in railroad work all his life, holding positions with several roads and being associated with a great many more in a consulting capacity. As a result of this experience he was a member of the Locomotive Power Test Code Committee of the A. S. M. E. He was also member and manager of the Franklin Institute, member and director of the Engineers Club of Philadelphia, and a member of the National Geographic Society. He was the author of a number of textbooks for engineering colleges. In 1918 he was made Federal Administrative Engineer for Pennsylvania, but failing health made it necessary for him to give up that work after a short term of service and retire to private life. Mr. Henderson had recently returned from a summer trip to Maine.

Personals

Harry E. Duren has become manager of the Greenfield (Mass.) Electric Light and Power Co. For the last two years he has served as power engineer for the Fall River (Mass.) Electric Light Co.

C. R. Alden, formerly director of the School of Engineering, Detroit Institute of Technology, is now professor of electrical engineering and dean of the College of Engineering at Ohio Northern University, Ada, Ohio.

Charles F. Leonard is now vice president in charge of business promotion for Walter N. Polakov & Co., Inc., engineering counsel, having left his position as technical advisor with the American Institute of Weights and Measures.

Floyd W. Parsons, who has handled the "Everybody's Business" department in the Saturday Evening Post for the last few years, and who was formerly editor of *Coal Age*, a McGraw-Hill paper, has become editorial director of the *Gas Age-Record*.

Society Affairs

Calendar

American Society of Mechanical Engineers—Annual meeting at New York City, Dec. 5-8. Topic, "Elimination of Waste." Secy., Calvin W. Rice, 29 West Thirty-ninth St., New York City.

National Association of Practical Refrigerating Engineers—Annual convention at Hotel Lorraine, Philadelphia, Nov. 30-Dec. 3. Secy., Edward H. Fox, 5707 West Lake St., Chicago.

American Society of Refrigerating Engineers—Annual meeting at New York City, Dec. 5-7. Secy., William H. Ross, 154 Nassau St., New York City.

American Gas Association—Third annual convention and manufacturers' exhibition at Congress and Auditorium Hotels, Chicago, Nov. 7-12. Charles W. Person, 130 East Fifteenth St., New York City.

The National Society for Vocational Education is announcing plans for its 15th annual convention, at Kansas City, Mo., Jan. 5-7, 1922. The program is in charge of a committee headed by C. A. Prosser, of Dunwoody Institute, Indianapolis, Ind., and will include exhibitions and discussions of various subjects relating to vocational education, including industrial education and industrial rehabilitation. The society's address is 140 West Forty-Second St., New York City.

The Engineering Society of Buffalo will meet Nov. 1, at eight o'clock, at the Iroquois Hotel, to hear L. W. Wallace tell about the activities of American Engineering Council's Committee on the Elimination of Waste in Industry. Mr. Wallace is the secretary of the Council, which is the governing board of the Federated Engineering Societies, and had charge of the waste investigation, so that his speech should be of especial interest. The society has recently secured quarters in the Iroquois Hotel and plans to hold all meetings, dinners and social functions there in the future.

Business Items

Redfield & Fisher, Inc., 105 West Fortieth St., New York City, advertising agency, has announced that George N. Wallace, formerly in charge of the copy department of Hoyt's Service, Inc., has joined the firm, resulting in a change of name to Redfield, Fisher & Wallace, Inc.

The Vulcan Fuel Economy Co. has moved from the Transportation Building to Machinery Hall, 549 West Washington Blvd., Chicago. It is announced also that the withdrawal of George L. Simonds, long president of the company, has caused the election of a new directorate, which has elected Dr. Eugene Murray-Aaron president. Dr. Murray-Aaron has been secretary of the company for some years, is the inventor of some of the improvements in its gas-analysis instruments and is well known for his writings on applied science and similar subjects.

The Bethlehem Shipbuilding Corp. is planning to start the manufacture of Diesel engines on a large scale at its Alameda, Cal., plant. Both stationary and marine engines will be built, the marine field on the Pacific Coast being regarded as particularly favorable at this time. Frank E. Neitzel, superintendent of construction for the corporation and the designer and builder of its Alameda plant, has recently returned from a European trip, on which he studied foreign engine-building methods.

Trade Catalogs

Lubrication of the Steam Turbine.—The Texas Co., New York City, or Houston, Texas. A discussion of operating problems that should be helpful to the practical man.

Electric Equipment—Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin No. 1118, describing a new line of continuous rated polyphase induction motors and a new potential starter.

Hammer-Welded Pipe—National Tube Co., Frick Building, Pittsburgh. Bulletin No. 13, 8 x 11 in., 36 pages. An attractive booklet on large steel piping, containing many instructive illustrations and a number of tables on friction and velocity of water in pipes, etc. Of especial interest are the sketches showing different types of pipe joints and some matter on penstocks.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Qoting	Oct. 17, 1921	Oct. 24, 1921
Pool 1,	New York	$3.20	$3.25@3.50
Pocahontas	Columbus	2.65	2.50@2.75
Clearfield	Boston	1.95	1.75@2.15
Somerset	Boston	1.90	1.60@2.15
Pittsburgh	Pittsburgh	2.20	2.10@2.20
Kanawha	Columbus	2.05	2.00@2.30
Hocking	Columbus	2.00	2.00@2.20
Pittsburgh No. 8	Cleveland	2.15	2.10@2.25
Franklin, Ill.	Chicago	2.85	3.25@4.25
Central, Ill.	Chicago	2.25	1.75@2.75
Ind. 4th Vein	Chicago	2.50	2.35@2.75
Standard	St. Louis	1.75	1.75@2.25
West Ky.	Louisville	2.30	2.10@2.65
Big Seam	Birmingham	2.15	2.00@2.30
S. E. Ky.	Louisville	2.30	2.00@2.40

New York—On Oct. 26, Port Arthur light oil 22@25 deg. Baumé, 5¼c. per gal. 30@35 deg., 7c. per gal. f.o.b. Bayonne, N. J.

Chicago—Oct. 22, for 24@28 deg. Baumé, 75@85c per bbl.; 32@36 deg. 2¼@2¾c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Oct. 25 f.o.b. refinery; Pennsylvania, 36@40 deg., 6@6¼c. Oklahoma, 24@30 deg., $1@$1.10 per bbl.; gas oil, 32@34 deg., 3¼@3½c. per gal., 36@38 deg., 3¾c., 38@40 deg., 4@4½c. per gal.

St. Louis—Oct. 22, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, $1.00. per bbl.; 26@28c. deg. $1.10; 28@30 deg. $1.20 32@34 deg., 5c. per gal.

Philadelphia—On Oct. 24, 26@28 deg. Baumé Oklahoma, 50c. per bbl.; 30@34 deg., Oklahoma (group 3) 75c. per bbl.; 16@20 deg. Seaboard, 3½c. per gal.

Cincinnati—Oct. 24, for 26@30 deg. Baumé, 5½c.; Diesel, 38@40 deg., 5¾c. per gal.

Cleveland—Oct. 24, for 26@30 deg. Baumé, 4½c. per gal.

New Construction

PROPOSED WORK

Mass., Boston—Meisel Press, Dorchester Ave., will soon award the contract for a 1 story, 300 x 400 ft. machine shop near Locust St. About $300,000. McNaughton & Cleverdon, 19 Congress St., archts.

Mass., Rutland—Treasury Dept., J. A. Wetmore, Supervising Archt., Wash., D. C., will receive bids until Nov. 22 for the construction, mechanical equipment, pumping plant, etc., for the extensions to the Administration building of the United States Public Health Service Hospital here.

Conn., Meriden—The Meriden City Hospital, E. W. Pierce, Chn., will soon award the contract for a 4 story, 50 x 150 ft. addition to hospital including a steam heating system on Cook Ave. About $350,000. C. S. Palmer, 114 Whitney Ave., New Haven, Archt.

Conn., New Haven—St. Brendens R. C. Church, 380 Sherman Ave., is having plans prepared for a 1 and 3 story church and school on Whalley and Ellsworth Aves. About $300,000. G. A. Zunner, 182 High St., Hartford, archt.

N. Y., Buffalo—The Bd. Educ., Telephone Bldg., plans to build a high school. About $1,700,000.

N. Y., New York—R. T. Lyons, archt., 342 Madison Ave., is making sketches for a 16 story apartment at 164 West 75th St., for the 166 West 75th St. Corp. About $600,000.

N. Y., Rochester—The Ingle Machine Co., Winton Rd., N., is in the market for one 20 hp. reversing planer motor.

N. Y., Scottsville—The Village is having plans prepared for a pumping and filteration plant equipment, etc. Hopkins & Field, 349 Cutler Bldg., Rochester, engrs.

N. Y., Wilson—The Village is having plans prepared for water works system, including pumping station and equipment, water tower, etc. Hopkins & Field, 349 Cutler Bldg., Rochester, engrs.

N. J., Jersey City—The Hudson & Manhattan R. R. Co., Power House, will receive bids until Nov. 4 for a 3,000 kw. synchronous converter, 650 volt., D.C.; three 1,000 kva. converter transformers, 11,000 volt; and one converter switching equipment, consisting of high tension circuit breaker and interlocking equipment.

Pa., Ebensburg—The Borough of Ebensburg plans election to vote $80,000 bonds to purchase site for reservoir, pumping station, and laying pipe lines, etc. H. F. Dorr, Trust Bldg. Engr.

Pa., Harrisburg—The Dept. of Public Safety received bids for Contract A—Enlargement of filtration plant including the installation of 8 new filters, a filter bldg., reservoir, sedimentation basins, etc., from Whiting Turner Constr. Co., 403 Stewart Bldg., Baltimore, Md., $375,588.02; S. W. Shoemaker & Son, 421 Walnut St., $421,584; and J. L. Eyre, 1537 Commercial Trust Bldg., Phila., $449,298.

Contract B—Improvements to pumping station including two new 15,000,000 gal. high lift centrifugal pumps, boilers, boiler house, etc., from Rausom & Anderson, 136 Liberty St., New York City, $200,337.70; J. H. Wickersham, Brennan Bldg., Lancaster, $243,622.12; and Roberts Filter Mfg. Co., 6th and Columbia Sts., Darby, Pa., $243,745. Noted Oct. 4.

Pa., Philadelphia—(Change of date) The Dept. of Transit, 1211 Chestnut St., W. S. Twining, Dir., will receive bids Nov. 4 for a 40 x 60 ft. sub-station on Cumberland and Kensington Aves. and one 40 x 70 ft. on Cumberland and Arrott Sts. Equipment including 2 signal transformers, switchboard, etc., will be installed in same. H. H. Quimby, 1211 Chestnut St., Engr. Noted Sept. 27.

Pa., Reading—The Reading Hospital c/o Dr. C. W. Bachman, 221 North 6th St., is having revised plans prepared for an addition to hospital on Front and Spring Sts. About $400,000. F. A. Mullinberg, 1713 Sansom St., Phila., archt. Noted Jan. 18.

W. Va., Charleston—The Beni-Kedem Temple, A. A. O. N. M. S. is having plans prepared for a 3 story, 100 x 240 ft. temple and theater bldg. on Kanawha St. About $600,000. C. M. & G. L. Rapp, 190 North State St., Chicago, Ill., archts.

La., Alexandria—Treasury Dept., J. A. Wetmore, Supervising Archt., Wash., D. C., received bids for a refrigerating plant in the United States Public Health Service Hospital from the Rentz Engr. Co. and Machine Works, Inc., New Orleans, $20,070; York Mfg. Co., York, Pa., $15,295; and the Amer. Carbonic Mchy. Co., Wisconsin Rapids, Wis., $22,300. Noted Oct. 11.

O., Canton—The Bd. Educ., W. C. Lane, clk., will receive bids until Nov. 2 for a 3 story, 144 x 226 ft. high school, including a steam heating system on 6th St. About $400,000. G. Hammond, 705 Rose Bldg., Cleveland, archt. Noted April 19.

O., Cleveland—The Bd. Educ., F. G. Hogen, Dir., East 6th St. and Rockwell Ave., is having plans prepared for a 3 story, 250 x 300 ft. high school, including a steam heating system on East 152nd St. and St. Clair Ave. About $1,500,000.

Mich., Detroit—The Bd. of Fire Comrs., Wayne and Larned Sts., will receive bids until Nov. 21 for furnishing equipment including 3 electrical driven centrifugal pumps, motor generators, etc., for High Pressure Pumping Station at foot of Randolph St. Smith, Hinchman & Gryils, 710 Washington Arcade, Engrs.

Mich., Detroit—The County of Wayne, County Bldg., is having plans prepared for a 3 story county office building on Fort and Randolph Sts. About $750,000. Smith, Hinchman & Grylls, 710 Washington Arcade, engrs.

Mich., Detroit—The Michigan Workmen Compensation Insurance Co., c/o Stratton & Snyder, Union Trust Bldg. and M. R. Burrowes, 2631 Woodward Ave., archts., is having plans prepared for a 6 story, 43 x 126 and 45 x 60 ft. industrial hospital including a steam heating plant. About $500,000.

Mich., Lincoln Park—The Village is having plans prepared for a water works system including pumping equipment, etc. About $175,000. R. A. Murdoch, 603 Free Press Bldg., Detroit, Engr.

Mich., Traverse City—The Bd. Educ. is having plans prepared for a 3 story high school including steam heating and mechanical ventilating system. About $300,000. E. S. Batterson, Kalamazoo, archt.

Ill., Aurora—The Aurora Lodge, A. F. & A. M., c/o E. M. Birch, 197 West Park Ave., is having plans prepared for a 5 story, 92 x 150 ft. Masonic temple, including a steam heating system. About $250,000. W. Q. Bendus & Co., Steinway Hall, Chicago, archts. Noted Sept. 27.

Ill., Chicago—The Haniffin Mfg. Co., 621 South Kolmar Ave., is having plans prepared for a 2 story, 90 x 160 ft. factory for the manufacture of special machinery, on Knox and Wellington Sts. About $200,000. Architect not announced. A steam heating system will be installed.

Ill., Naples—(Change of date)—The Valley City Drainage and Levee Dist., W. Severns, chmn., will receive bids until Nov. 3 for a pumping plant.

Ill., Quincy—Pinkelman & Cory, Gem Theater Bldg., are having plans prepared for an 8 story theater and office building, including a steam heating system on Washington Square. About $1,000,000. D. S. Klafter, 64 West Randolph St., Chicago, archt.

Wis., Milwaukee—The Amer. Hide & Leather Co., 1320 Elston St., Chicago, Ill., is having plans prepared for a 6 story tannery and power house on Commerce St. About $1,000,000, including equipment. Lockwood Green & Co., 60 Federal St., Boston, Mass., archts. and engrs. Noted Oct. 18.

Wis., Neenah—The Dairymen's Storage Co., H. Krumrey, Plymouth, plans to build a 3 story, 40 x 60 ft. cold storage plant. About $45,000. Architect not selected.

Wis., Whitewater—The Bd. of Normal School Regents, W. Kittle, Secy., is having plans prepared for a 5 story, 60 x 150 ft. Normal school, including a steam heating system. About $250,000. A Peabody, Capitol Bldg., Madison, archt.

Minn., Adrian—The Village will receive bids until Nov. 8 for equipment for proposed power house, including one 150 kva. steam generator unit, uniflow type; one 120 kva. generator for use on present engine; one electric switchboard, etc. A. S. Dever, 486 Endicott Bldg., St. Paul, archt.

Minn., Forest Lake—The Village will receive bids until Nov. 4 for a well, pump house, and equipment. Druar & Milinowski, 504 Globe Bldg., St. Paul, engrs. Former bids rejected. Noted Oct. 11.

Kan., Coffeeville—The Bd. Educ., c/o H. E. Martin, Pres., is having plans prepared for a 2 story high school, including a steam heating system. About $250,000. A. T. Simmons, 1st Natl. Bank, Bloomington, archt.

Mont., Bozeman—The University of Montana, Bd. of Trustees, State Capitol, Helena, will receive bids about Dec. 20 for a heating plant and equipment in connection with various other buildings at the College of Agriculture and Mechanic Arts, here. Cost $150,000. F. Wilson, Bozeman, Archt. for building only. Pillsbury Co., 1200 2nd St., Minneapolis, Minn., for heating plant. Noted June 28.

Mont., Missoula—The University of Montana, Bd. of Trustees, State Capitol, Helena, will receive bids about Dec. 20 for a heating plant and equipment in connection with various other buildings at the State University here. Cost about $140,000. O. Bakke and C. J. Forbes, Archts., for building only. Pillsbudy Co., 1200 2nd St., Minneapolis, Minn., for heating plant. Noted June 28.

Mo., Kansas City—The Clark Estate Co., 3312 Bway., is having plans prepared for a 12 story hotel (Embassy), including a steam heating system. About $2,700,000. W. W. Ahlschlager, 65 East Huron St., Chicago, Ill., archt.

Tex., Wortham—The city plans election Nov. 7 for bond issue for waterworks, sewers and electric light plants. Engineering Service Co., Sumpter Bldg., Dallas, consulting engrs.

Okla., Oklahoma City—The Oklahoma Club, c/o J. Shartel, will soon receive bids for a 6 story, 125 x 140 ft. club, including a steam heating system. About $350,000. Former Bids rejected. Hawk & Parr, Magnolia Bldg., archts. Noted Oct. 4.

Ariz., Prescott—Treasury Dept., J. A. Wetmore, Supervising Archt., Wash., D. C., will receive bids until Nov. 16 for the installation of mechanical equipment, refrigerating apparatus and laundry equipment, also boilers for outside service, etc., at the United States Public Health Service Hospital No. 50, Whipple Barracks, here.

Wash., Walla-Walla—Treasury Dept., J. A. Wetmore, Supervising Archt., Wash., D. C., will receive bids until Nov. 21 for various buildings including boiler house and laundry for the United States Public Health Service Hospital here. About $400,000.

Ore., Oak Grove—The Portland Ry. Light & Power Co., Electric Bldg., Portland is having plans prepared for a hydro-electric power development, first unit to develop 20,000 kw. to be known as Oak Grove development. Total cost about $2,000,000. T. Pumfrey, Electric Bldg., Portland, Ch. Engr.

Ore., Portland—The Multnomah County Improvement Dist. plans reclamation of part of Sauvies Island by building 12 mile of dike at lower end, pumping plant including two 24 in. centrifugal pumps will be required. Total cost, about $200,000. T. A. Garrow, 617 East 10th St., N., Engr.

Ore., Portland—The Port of Portland will soon be in the market for lighting and power equipment for the machine shop and repair plant at St. Johns Dry Docks, including 7 motors 5 to 25 hp., conduits, etc. About $6,000. J. H. Polhemus, c/o Port of Portland, 916 Spaulding Bldg., Engr. and Genl. Mgr.

Cal., Los Angeles—The County Bd. of Supervisors, Hall of Records, received bids for furnishing and installing engine generator set in the power house at the County Hospital from Tlewellyn Iron Wks., Main and Redondo Sts., $13,990; and T. Haverty Co., 8th and Maple Sts., $19,621. Noted Oct. 11.

Que., Montreal—The B. & T. Toy Co., 319 Champlain St., I. Dupras, Mgr., is in the market for a 5 hp. electric motor for proposed plant at 2655 Papineau Ave.

Que., Verdun—The city is having plans prepared for the installation of 2 electric pumps with 5,000,000 gal. capacity each to replace steam system. A. E. Gyshens, City Hall, engr.

Ont., Brockville—E. F. Phillips Electrical Wks., Ltd., DeGaspe St., Montreal, Que., manufacturers of copper electric wire and cable, plans to establish main plant here to cost between $2,500,000 and $3,000,000. The first unit of plant is to be a rolling mill.

Ont., Chatham—The Chatham Crystal Ice Co. is having plans prepared for an artificial ice plant. About $60,000. J. W. Leighton, Bartlett Bldg., Windsor, Archt.

Ont., Sandwich—The County Council, W. P. Coyle, 472 Sandwich St., Windsor, will soon receive bids for a 2 story, 150 x 200 ft. jail including laundry, boiler house and steam boilers. About $250,000. Nichols, Sheppard & Colthurst, Windsor, Archts.

CONTRACTS AWARDED

Mass., Springfield—The Springfield Ice Co., 47 Dwight St., has awarded the contract for a 1 story, 100 x 147 ft. ice plant to E. F. Carlson Co., 244 Main St.

Mass., Wakefield—The Town Bd. has awarded the contract for a 3 story, 86 x 208 ft. and 50 x 150 ft. high school, etc., on Main St. to C. H. Cunningham & Sons, Lynn. About $300,000. A steam heating system will be installed. Noted May 23.

Conn., New Britain—The New Britain General Hospital, 92 Grand St., has awarded the contract for a 3 story, 50 x 110 ft. addition to hospital, consisting of ward and nurses' home on Grand St. to H. Wales Lines Co., 134 State St., Meriden. A steam heating system will be installed. Noted Mar. 15.

Conn., New Haven—The Estate of E. Malley, 902 Chapel St., has awarded the contract for a 1 story, 72 x 80 ft. power plant on Temple St. to Connor & Haggarty, Inc., 172 Norton St. About $50,000. Noted Aug. 30.

Pa., Philadelphia—J. C. Hendricks, Real Estate Trust Bldg., will build two 2 story, 27 x 65 ft. apartments on Walnut Lane and Wayne Ave. About $250,000. A steam heating system will be installed.

Pa., Philadelphia—The Ivins Tube Wks., Coventry and Chestnut Sts., Oak Lane, will build a 1 story steel tube rolling mill on Coventry and Chestnut Sts., Oak Lane. About $250,000.

Pa., Pittsburgh—The Air Reduction Co., 342 Madison Ave., New York City, has awarded the contract for a 2 story acetylene plant on Ridge Ave. here, to Hughes-Foulkroud Co., 600 Oliver Bldg. About $250,000. Noted Sept. 20.

Fla., Orlando—The Orange Hotel Co., J. Fange, Pres., has awarded the general contract for an 11 story, 100 x 105 ft. hotel on Orange and Oak Sts. to C. E. Hillyer, Jacksonville. About $550,000. Steel to the Virginia Bridge & Iron Co., Roanoke, Va. About $300,000. A steam heating system will be installed. Noted Aug. 9.

O., Oberlin—The Bd. Educ., has awarded the contract for a steam heating system for the proposed 2 story, 75 x 180 ft. school to Carey-Hall-Allen Co., Defiance, $60,590.

Ill., Chicago—Anderson & Miller, c/o P. F. Olsen, 127 North Dearborn St., have awarded the contract for a 3 story, 200 x 217 ft. apartment on East Lake Terrace to J. Anderson & Son, 5723 Winthrop Ave. About $550,000. A steam heating system will be installed.

Ill., Chicago—G. B. Bumgardner, 215 North State St., has awarded the contract for a 3 story, 150 x 190 ft. apartment at 6930 Crandon Ave., masonry to Rutledge Bowe Constr. Co., 64 West Madison St. and the carpentry to Alson & Johnson, 4736 Manor Ave. Total cost about $275,000. A steam heating system will be installed.

Ill., Chicago—Cook County Comrs., 519 County Bldg., have awarded the contract for a 3 story, 50 x 135 ft. detention home on Ogden and Roosevelt Aves. to J. W. Snyder Co., 122 South Michigan Ave. About $670,000. A steam heating system will be installed. Noted Sept. 13.

Ill., Chicago—The Illinois Merchants Trust Co., 112 West Adams St., has awarded the contract for a 21 story, 178 x 323 ft. bank and office building on La Salle and Congress Sts. to Henry Ericsson Co., 139 North Clark St. About $9,000,000. A high pressure steam heating system will be installed. Noted Sept. 20.

Wis., Beaver Dam—Price & Ruland Co. has awarded the contract for a 2 story, 60 x 126 ft. factory, for the manufacture of dairy products, to the Hutter Constr. Co., 128 Western St., Fond-du-Lac. About $45,000. Power machinery, boilers, etc. will be required.

Wis., LaCross—Sisson, Sielstad, Hougen Co., 115 North Front St., have awarded the contract for a 5 story wholesale grocery warehouse on Front St., to C. W. Noble, 206 State Bank Bldg. and plans to install cold storage refrigeration machinery.

Wis., Milwaukee—The City Sewerage Comn. has awarded the contract for a boiler house on Jones Island to G. E. Kahn, 114 Grand Ave., $15,900.

Kan., Salina—The Masonic Temple Assn., c/o E. A. Hiller, Secy., P. O. Box 52, has awarded the contract for a 3 story Masonic temple to the Eberhardt Constr. Co. About $750,000. A steam heating system will be installed.

Kan., Wichita—G. H. Siedhoff Constr. Co., 1st and Market Sts., will build a 6 story, 80 x 260 ft. hotel on Douglas and Waco Sts. About $500,000. A steam heating system will be installed. Owner will build by day labor. Noted Oct. 4.

Okla., Tulsa—Dr. W. E. Wright, 211 Wright Bldg., has awarded the contract for an 8 story, 46 x 104 ft. office bldg. to G. W. Langford Co., Columbia Bldg. Cost plus percentage basis. A steam heating system will be installed.

Cal., Pasadena—The Pasadena Hospital Assn., Congress St., has awarded the contract for a 4 story, 100 x 120 ft. hospital on Congress St., to W. Crowell, Chamber of Commerce Bldg., $175,000. Steam heating and refrigerating systems will be installed. Noted May 23.

Wash., Seattle—The Bd. of Pub. Wks. awarded the contract for a tunnel for the Gorge Creek plant of the Skagit River power development to R. C. Storrie & Co., Crocker Bldg., San Francisco, Cal., $2,203,865.